Corrigendum

Page 7: Ivory Coast: for 0.48 read 4.8;

Page 10: Central Zaire: insert 17 under "Typical value for R";

Page 32: Line 3: for "fields" read "yields";

Page 36: A. Line 2: for 15 000 read 1 500.

Changes in shifting cultivation in Africa

Forestry Department

FAO
FORESTRY
PAPER
50

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ISBN 92-5-102151-1

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FOREWORD

In recent years shifting cultivation has received growing attention from FAO governing and advisory bodies. The Organization has been asked to study the biological, social, economic and cultural aspects of this food production system and to draw up multi-disciplinary programmes and guidelines for improving its productivity.

Within the context of this mandate from our member countries the FAO Forestry Department carried out in 1982-83 a comprehensive study of "alternatives to shifting cultivation in the use of forest land". This work was coordinated by a working group which included officers of the Agriculture and the Economic and Social Policy Departments of FAO, as well as a sociologist from the Overseas Development Institute, U.K. (Dr. C. Oxby).

The aim of the present study, which is confined to those zones of Africa receiving 1 000 mm or more of annual precipitation, is to assess the extent and distribution of shifting cultivation in Africa and to document and evaluate developments resulting from recent demographic and other land pressures. The study also draws, inter alia, upon the findings of seven case studies carried out specifically for that purpose in Ghana, Ivory Coast, Madagascar, Senegal, Sierra Leone and Tanzania (two studies).

This food production system has been practised successfully and safely for centuries as it was fully adapted to the specific climatic and edaphic conditions prevailing in each forest region. However, because of increasing population pressure this is no longer the case in most areas of tropical Africa. Spontaneous or planned changes take place in which forestry and forest trees play a beneficial role and can in this way contribute to the socioeconomic development of rural communities concerned.

I fervently hope that this review of certain aspects of shifting cultivation in Africa and the improvements suggested will not only add to the growing volume of our knowledge on, and better understanding of, shifting cultivation, but will also contribute to its transformation into a more positive and productive cropping system which could be practised in full harmony with the natural surroundings and the needs of their human occupants.

M.A. Flores Rodas
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and
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INTRODUCTION

The first part of the report concerns the definition of shifting cultivation and its distribution in Africa. Shifting cultivation, defined as long fallow agriculture as opposed to short fallow and permanent agriculture, is no longer as common in Africa as formerly. Moreover, it is usually combined with other forms of agriculture so that a given household exploits some fields by shifting cultivation, usually those with food crops, and other fields by using other practices.

With growing population densities and increasing land pressure there is not enough land to leave a long period of fallow and farmers are automatically changing from long fallow cultivation to short fallow and permanent cultivation on all or part of their fields, although they may resist such change until the last moment because of the lower labour requirements of long fallow agriculture. These spontaneous modifications of shifting cultivation are dealt with in a second part of the report.

The third part of the report deals with planned change, which falls into two categories: one is to improve shifting cultivation, and this is illustrated by attempts to plant certain soil-enriching trees in the fallow, and to make a better use of the cleared vegetation by exploiting the timber rather than burning it, the latter being the normal practice. But the main form of planned change is to discourage shifting cultivation and propose alternatives. The alternatives considered are:

- the various forms of "taungya", or cultivation of food crops in the early years of a Forestry Department tree plantation in gazetted forest reserves; these have often met with farmer reluctance because they only give temporary access to land;
- lowland rice is a viable alternative where there is adequate suitable land;
- the planting of perennial agricultural crops may represent an attractive strategy for wealthier farmers who can afford to wait until the trees become productive; however, this may not be so attractive to the smaller farmer;
- finally, various forms of agroforestry not yet practised in Africa are considered; however, as these are only in the early stages of implementation there is little information on acceptability to farmers.

The main conclusions and recommendations are presented in a final section. Reference is made throughout to an Appendix where projects carried out in areas of fallow agriculture are listed, alphabetically by country, with brief local and project details.

The generous assistance of the following institutions and their staff is gratefully acknowledged:

- Overseas Development Institute, London, U.K. (Dr. C. Oxby);
- Department of Forestry, Wageningen Agricultural University, Netherlands (Dr. K.F. Wiersum and his colleagues)
- Institut de recherches d'agronomie tropicale et de cultures vivrières, Paris, France (M.M. Borget and his colleagues)
- Silviculture Research Station, Forest Division, Dar-es-Salaam, Tanzania (Dr. A.G. Mugasha and his colleagues)
- Forest Products Research Institute, Kumasi, Ghana (Dr. J. Brookman Amissah).

1. GENERAL ASPECTS OF SHIFTING CULTIVATION IN AFRICA

1.1 Definition of shifting cultivation

The term shifting cultivation is a difficult one to define since it is used by different people in different contexts in widely differing ways. During the FAO/SIDA Regional Seminar on Shifting Cultivation and Soil Conservation in Africa, held in Ibadan, Nigeria, in July 1973 (see FAO/SIDA 1978 and Unesco/UNEP/FAO 1978) there was a working group on terminology; to give an indication of the range of usages of the term shifting cultivation, the following is a quote from the report of this working group:

> "The essential characteristics of shifting cultivation are that an area of forest is cleared, usually rather incompletely, the debris is burnt, and the land cultivated for a few years - usually less than five - and then allowed to revert to forest or other secondary vegetation before being cleared and used again. The system varies in detail from place to place. Consequently many names are used for it. Nye and Greenland (1960) and many others use the term shifting cultivation as a general term embracing many variations of natural fallow cultivation systems. Conklin (1957) discusses the revived term swidden farming, and proposes its use for the more general descriptions of shifting cultivation, leaving this last expression for the more specific types of agricultural practices. Ten variables are proposed to distinguish different types of swidden farming according to agronomic and cultural practices. Spencer (1966) lists numerous terms related to shifting cultivation, mostly from South-East Asia and proposes 19 basic qualitative elements including such factors as ecological adaptation, labour efficiency, erosion control, etc. Watters (1971) includes in the definition of shifting cultivation the use of primitive tools and the subsistence economy usually associated with its practice." 1/

It is not the purpose of this study to dwell on problems of definition; merely to warn readers of the variety of definitions in use. In case of confusion, it is probably helpful to put the term shifting cultivation to one side and to concentrate on the more tangible and easily identifiable factors which most authors would agree to be crucial in the identification of shifting cultivation versus other forms of land cultivation, and in the distinction between different types of shifting cultivation. Such factors are (see Figure 1):

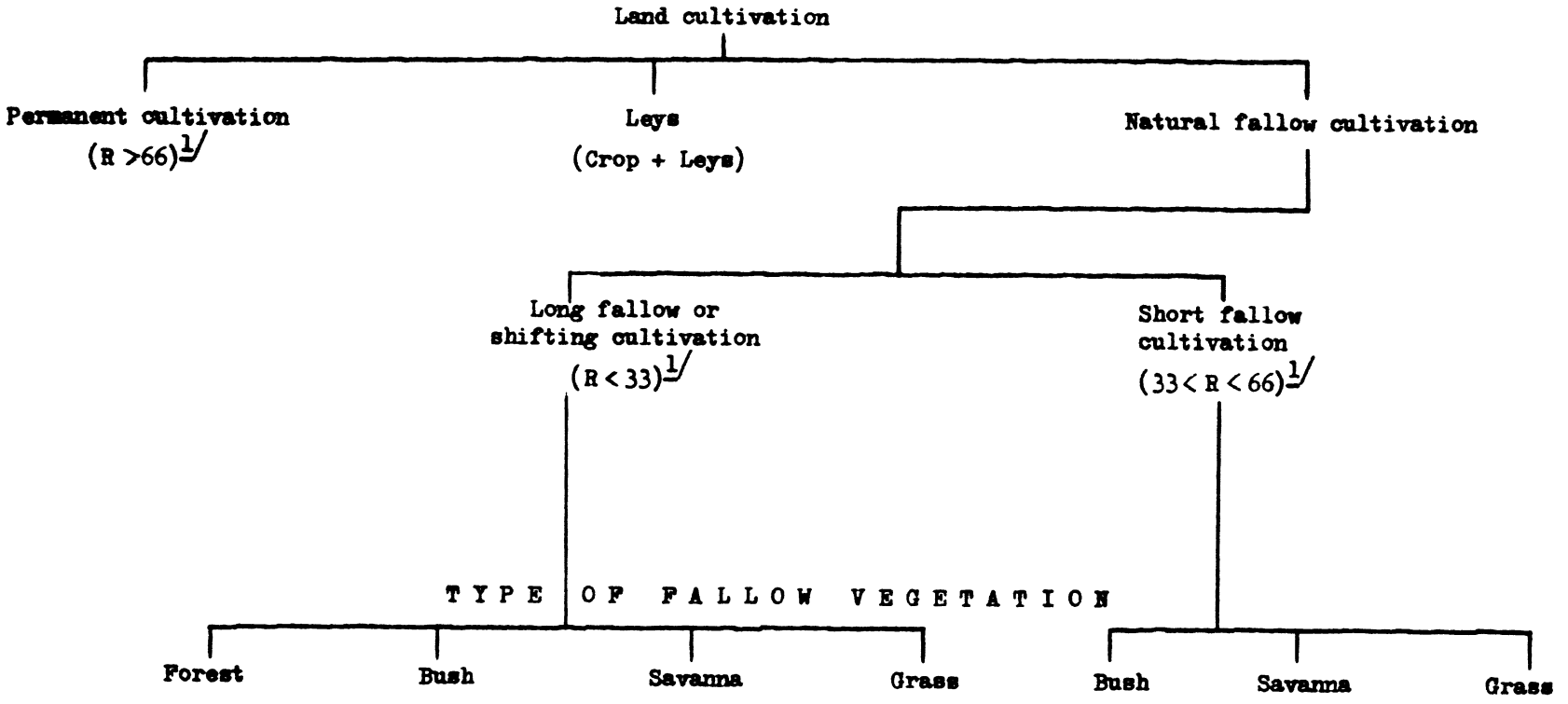
a) Cultivation is interrupted by a period of natural fallow; it is not permanent (or continuous).

b) The duration of the fallow period and the cultivation period may vary, as well as the ratio between these two periods (we shall see below how R, the intensity of the rotation, is calculated from this information). Shifting cultivation is characterized by long periods of fallow and in this respect is in opposition to short fallow cultivation.

c) A wide variety of vegetation may grow in the fallows, from forest to grasses. The former is characteristic of shifting cultivation and the latter, of short fallow cultivation.

1/ (Unesco/UNEP/FAO 1978:467-8).

Figure 1: Types of land cultivation (after Unesco/UNEP/FAO 1978:468 and Ruthenberg 1980:16)



1/ For definition of R see text.

d) The fallow period may be long enough to restore soil fertility, or in some cases not long enough. In the latter case, the fallow period may be labelled "accelerated" (Unesco/UNEP/FAO 1978:468); but Olofson (1982:13) points out that in this case the fallow period is not so much "accelerated" as "interrupted". The minimum fallow period for restoring soil fertility is variable and depends on a variety of factors, including rainfall, soil type, slope, vegetation type, intensity of previous cultivation, type of crops previously grown, type of crops to be grown, method of clearing, use of fertilizer, and so on.

e) The population density associated with shifting cultivation is relatively low, in order for there to be enough land to leave a proportion of it to fallow.

f) In the case of long fallow periods characteristic of shifting cultivation, housing may be semi-permanent, or farmers may have permanent homes in villages and temporary homes by the fields. Shorter fallow periods on the other hand are associated with permanent housing.

This list may, of course, be extended according to the interests of the enquirer: the forester will go into further details about the woody vegetation; the soil scientist, about the soil types; the agriculturalist, about the crop rotations; and the socio-economist, on labour requirements. However, answers to the above questions will already provide a good basis upon which to decide whether or not one is dealing with shifting cultivation.

It is difficult to make a rigid distinction between shifting cultivation and other types of agriculture, because there are no sharp dividing lines between them; only gradations. There is, however, a general agreement that the relationship between the length of the fallow period and the length of the cultivation period is crucial. Allan writes about the land-use factor, which is most conveniently expressed as the number of "garden areas" required, a "garden area" being the area in cultivation at any one time. "For example, in the case of a soil capable of maintaining its fertility under alternate crop and fallow periods of equal duration only two garden areas will be required, while, at the other extreme, on a very poor soil allowing of only two years cultivation followed by a full period of woodland regeneration the requirement may be no less than sixteen garden areas. The land-use factor is two for the one type and 16 for the other". (Allan 1965:30). The land-use factor, L, can be expressed in the following way, C being the length of the cultivation period and F the length of the fallow period:

$$L = \frac{C + F}{C}$$

The examples given in the quotation by Allan above, can be expressed as follows:

$$L = \frac{3 + 3}{3} = 2$$

$$L = \frac{2 + 30}{2} = 16$$

Ruthenberg (1980:15), on the other hand, uses the concept of the intensity of the rotation, R, which is the relationship between crop cultivation and fallowing within the total length of one cycle of land utilization:

> "Following the suggestion of Joosten (1962), we define the symbol R as the number of years of cultivation multiplied by 100 and divided by the length of the cycle of land utilization.1/ The length of the cycle is the sum of the number of years of arable farming plus the number of fallow years. The characteristic R indicates the proportion of the area under cultivation in relation to the total area available for arable farming. If, for instance, 40 per cent of the available arable land in one holding is cultivated, the R is 40.

1/ We have thus: $R = \frac{100}{L}$

As long as fallow farming has an extensive character, in which many fallow years follow a short period of cultivation, R remains very small. If for example, 18 fallow years succeed 2 years of cultivation, as is frequently the case in the rainforest, R amounts to 10. This extensive type of fallow farming is generally designated shifting cultivation, because the shifting of fields within a broad area of wild vegetation usually results in the gradual relocation of the farming population. On the other hand, it should not be forgotten that there are a number of regions where stationary populations practise shifting cultivation.

The larger R becomes, the higher is the percentage of the area cultivated annually in relation to the total area available for arable farming, and the more stationary the character of the farming becomes. When cultivation is extended so far at the expense of fallowing that the characteristic R reaches or exceeds the value 33, then we can hardly speak of a shifting of the fields any more. A level of intensity of land utilization has been achieved that Terra and Nye and Greenland designate semi-permanent cultivation, and that Faucher designates stationary cultivation with fallowing. A characteristic R value of 50 is obtained, for example, if 7 fallow years succeed 7 years of cultivation. This book (Ruthenberg's) uses the term "fallow system". When the R value exceeds 66, and the soil is cultivated nearly every year or even more often, then permanent farming is being practised. Permanent farming may again be conveniently classified according to the degree of multiple cropping. An R value of 150 would indicate that 50 per cent of the area is carrying two crops a year, and a value of 300 would indicate that three crops a year are being grown." (Ruthenberg 1980:15-16).

Ruthenberg's R factor may be expressed in the following way (C represents the cropping period in years, and F the fallow period):

$$R = \frac{C \times 100}{C + F}$$

The examples given in the quotations by Ruthenberg above may be expressed as:

$$R = \frac{2 \times 100}{2 + 18} = 10$$

$$R = \frac{7 \times 100}{7 + 7} = 50$$

The first example would be classified by Ruthenberg as a shifting cultivation system; the second, as a fallow system.

It is tempting to adopt Ruthenberg's classification on account of his wide knowledge of farming systems and clear analysis of them. However, the present author draws attention to two problems. One is the danger of putting too much weight on the actual duration of the fallow and cultivation periods, since these may depend on a variety of factors, as we have seen in d) above.

Another is a certain ambiguity in a terminology which divides "natural fallow systems" into "fallow systems" and "shifting systems", since the latter are fallow systems <u>par excellence</u>. This ambiguity can be explained by the note to the quotation by Ruthenberg above in which he explains that he was encouraged to introduce the term "fallow systems" to replace the term "semi-permanent farming" which was used in the first edition of his book. The earlier opposition between "semi-permanent" and "shifting" seems more logical than the present one between "fallow" and "shifting" syst

In the final event, everyone has to make the decision about which terminology suits his purposes best. The most acceptable definition of shifting cultivation appears to be that recommended by the FAO/University of Ibadan Workshop on Shifting Cultivation held in July 1982:

"The workshop recommended the adoption of an operational definition of

periods of continuous cultivation are followed by relatively long periods of fallow."
(FAO/UI 1982, Recommendations, p. 2).

And, consequently, the use of the term "long fallow agriculture" as equivalent to shifting cultivation.

1.2 Situation in tropical Africa

On the question of out-of-date information, FAO Study (1984:7) draws attention to the well-known map by W.B. Morgan, which is still frequently reproduced, and which shows shifting cultivation and bush fallow over most of west, central and east Africa. This map was based on ethnographic and agricultural data which had, in many cases, been collected very much earlier than the publication date of 1969; although it is a useful historical statement, it should not be used as a guide for present policy.

There is a tendency to ascribe all types of subsistence cropping in Africa to shifting cultivation. This was true in the past but population pressure has brought about a reduction of fallows in various places to such an extent that the agriculture systems can no longer be classified as shifting cultivation in the meaning used in this study.

In the report for Africa of the FAO/UNEP Tropical Forest Resources Assessment Project, the following estimates of forest fallow areas are given. Although they provide an idea of the importance of shifting cultivation in Africa, some caution must be exercised to take into account several difficulties among which the following must be mentioned:

- the minimal rainfall corresponding to open tree formations (wooded and tree savannas) is generally somewhat lower than 1000 mm (say 800 mm) which is the minimum rainfall considered in this study;

- the forest fallow areas were estimated in many cases by interpretation of aerial photographs and satellite imagery on which the R value is not measurable;

- interpretation of remote sensing data does not always distinguish easily between forest fallow areas and areas of similar appearance such as degraded forests long abandoned by agriculture, or, in some cases perennial cash crops such as coffee plantations (for this latter case see Lassailly-Jacob, 1983:19);

Table 1: Estimated areas of forest fallows as at end 1980
(in thousand ha)
after FAO/UNEP, 1981

Country	Total area Km^2	Woody fallows		Total fallows ,000 ha	% of country
		Closed formations ,000 ha	Open formations ,000 ha		
Chad	1 284 000		800	800	0.6
Gambia	10 400		200	200	19.2
Mali	1 204 000		2 500	2 500	2.1
Niger	1 267 000		3 000	3 000	2.4
Senegal	196 722		1 750	1 750	8.9
Upper Volta	274 200		4 500	4 500	16.4
Northern savanna region	4 236 322		12 750	12 750	3.0

Country	Total area Km²	Woody fallows		Total fallows ,000 ha	% of country
		Closed formations ,000 ha	Open formations ,000 ha		
Benin	112 620	7	3 750	3 757	33.4
Ghana	238 538	6 500	2 680	9 180	38.5
Guinea	245 857	1 600	1 300	2 900	11.8
Guinea-Bissau	36 125	170	390	560	15.5
Ivory Coast	322 463	8 400	6 930	15 330	0.48
Liberia	96 320	5 500	40	5 540	57.5
Nigeria	923 768	7 750	4 900	12 650	13.6
Sierra Leone	73 326	3 860	415	4 275	58.3
Togo	56 800	250	1 200	1 450	25.5
West Africa	2 015 817	34 037	21 605	55 642	27.6
Angola	1 246 700	4 850	7 400	12 250	9.8
Cameroon	475 442	4 900	1 200	6 100	12.8
Central African republic	622 984	300	3 800	4 100	6.6
Congo	342 000	1 100		1 100	3.2
Equatorial Guinea	26 000	1 165		1 165	44.8
Gabon	267 670	1 500		1 500	5.6
Zaire	2 344 885	7 800	10 600	18 400	7.8
Central Africa	5 325 681	21 615	23 000	44 615	8.4
Burundi	27 834	14	10	24	0.8
Ethiopia	1 221 895	300	10 000	10 300	8.4
Kenya	580 367	55	550	605	1.0
Madagascar	590 992	3 500	-	3 500	5.9
Malawi	118 580	-	-	-	-
Mozambique	783 030	500	12 700	13 200	1.7
Rwanda	26 338	25	40	65	2.5
Somalia	637 539	-	50	50	0.001
Sudan	2 505 813	600	11 000	11 600	4.6
Tanzania	942 345	100	4 000	4 100	4.4
Uganda	196 840	-	1 600	1 600	8.1
Zambia	752 612	900	6 700	7 600	10.1
Zimbabwe	389 367	-	1/	-	-
East Africa and Madagascar	8 496 392	5 994	46 650	52 644	6.2

1/ undetermined.

Country	Total area Km^2	Woody fallows		Total fallows ,000 ha	% of country
		Closed formations ,000 ha	Open formations ,000 ha		
Botswana	574 992	-	-	-	-
Namibia	824 293	-	330	330	0.004
Tropical South Africa	1 399 285	-	330	330	0.002
Tropical Africa	21 473 497	61 646	104 335	165 981	7.7

Another important point is that where shifting cultivation does exist according to the proposed definition, it is now nearly always practised alongside other forms of cultivation*, so that a given household practises shifting cultivation on some fields and other more permanent forms of cultivation on other fields. Thus the use of temporary housing and shifting of homesteads, which may be necessary in some cases of sole reliance on shifting cultivation, is now not common, since farmers would not leave the site of their permanent fields. This fact was brought to the fore at the FAO/University of Ibadan Workshop on Shifting Cultivation:

> "It was generally agreed that the classical form of shifting cultivation involving relocation of homesteads is no longer a common practice in contemporary African agriculture."
> (FAO/UI 1982:1)

This misleading idea of shifting cultivation being practised by some people, whereas other forms of cultivation are practised by other people, has been encouraged by academic classifications of farming systems, which tend to separate them more than usually happens in reality. For example, Ruthenberg's otherwise excellent book on farming systems in thetropics has separate chapters on shifting cultivation systems, fallow systems, ley and dairy systems, systems with perennial crops, systems with permanent upland cultivation, systems with arable irrigation farming, and so on. It is thus easy to forget that any given household may practise at the same time several of these different "systems". For this reason FAO (1984) argues that shifting cultivation should not now be treated as a full fledged farming "system", but rather as a farming "subsystem". Thus several different agricultural subsystems, including shifting cultivation, constitute a single farming system.

Given these reservations, we can now consider the actual distribution of shifting cultivation. The FAO study mentioned above states:

> "Permanent agriculture is now the norm in all the highland areas of Ethiopia and Kenya, and in Uganda, Rwanda, Burundi, many parts of Tanzania, and Malawi. In Tanzania, "villagization" has reduced fallow lengths and encouraged a transition to semi-permanent cultivation... In Zambia, the bulk of the population concentrated along the line of the rail, moved over to permanent cultivation during the last 30 years. Shifting cultivation in both the last two countries is now found only in a few sparsely settled areas...

* In all of the recent cases of shifting cultivation in Africa located in the context of the present research, there were no examples of it not being combined with other forms of cultivation. This was also the case for FAO study, 1984. Even the Bemba of northeastern Zambia in the 1930s, who practised an archetypal form of shifting cultivation called "citemene", also had permanent river bed gardens (Richards, 1939:311).

In the Zaire basin, population is very sparse. There is some evidence that in recent years people have been concentrating round the towns, where more permanent agriculture is being practised. Cameroon contains much mountain country under permanent cultivation.

The southern part of West African countries are relatively densely populated. Tree crops are dominant on small holdings or plantations. Arable food farming is often a secondary activity. ... In south eastern Nigeria there is a densely populated region where small, permanently cultivated compound farms are the dominant type. Production from outlying, inadequately fallowed fields is of secondary interest. Farming itself is often subsidiary to non-farm occupations.

Within West Africa one also finds concentrations of rural population around annually cultivated riverine or swamp land. These permanent fields may or may not be supplemented by shifting cultivation on the uplands. Examples can be found in Sierra Leone and Ghana.

However, beyond the coastal belt lies the "middle belt" of West Africa, where population is sparser. Here shifting cultivation remains a major technique... In the drier zone north of the middle belt concentric ring farming or permanent cultivation is now the norm....

Thus, the main humid area where shifting cultivation remains the dominant form of farming is the middle belt of West Africa, between the coastal tree belt and the more permanently farmed northern plains. It is also still found in sparsely populated areas of Tanzania, Zambia and northern Mozambique and in the empty area of the Zaire basin."

(FAO 1984:7 and 9)

Tables 2 and 3 list some examples of shifting and short fallow agriculture in tropical Africa. Table 2 is based on pre-1961 data, and examples are divided into the different rainfall and vegetation zones. Table 3 is based on more recent data, collected from a number of sources. In addition to the crops cultivated under shifting cultivation or short fallow cultivation, it lists the main crops grown in continuous cultivation, in the context of the same farming system. At one end of the scale in table 3, the examples from Sierra Leone show a low R value, indicating the small proportion of land cultivated in relation to the total available land. At the other extreme are the final two examples, which have relatively high R values of 50 and so represent examples of short fallow cultivation, not shifting cultivation. Given Ruthenberg's cut-off point of an R value of 33, some of the cases listed in both tables 2 and 3 are in fact examples of borderline shifting cultivation/short fallow cultivation, or straight short fallow cultivation. Some of these examples will be used to illustrate points made in latter sections.

1.3 The use of fire

Under shifting cultivation, fire is commonly used as a way of clearing vegetation in a labour-saving way, and at the same time enriching the soil with ashes. This method has been criticised as wasteful and has led to countless measures to ban burning in different parts of the world, from early times until this day. For instance article 105 of the Legal Code issued in 1881 by the Merina Queen Ranavalona, Madagascar, states:

"On ne peut défricher la forêt par le feu dans le but d'y établir des champs de riz, de maïs ou toutes autres cultures; les parties antérieurement défrichées et brûlées, seules, peuvent être cultivées; si des personnes opèrent de nouveaux défrichements par le feu ou étendent ceux déjà existants, elles seront mises aux fers pendant cinq ans."

(Quoted in Uhart, 1962:108).

Table 2 : The length of the crop and fallow periods under shifting cultivation (based on 1961 source).

Place	Rain (mm per year)	Crops	Fallow vegetation/ species	Period in years Normal Crop	Normal Fallow	Excessive Crop	Excessive Fallow	Typical value for R	Remarks
MOIST EVERGREEN FOREST ZONE									
Nigeria									
(a) Umuahia	about 2300	yams, maize, manioc	Acioa barteri	1½	4-7	1½	2-2½	21	Loam derived from tertiary sands and clays: stumps of fallow carefully preserved.
(b) Alayi	about 2300	yams, maize, manioc	Anthonotha spp.	1½	7			18	Very loose sandy soil.
Central Zaire	1800	rice, maize, manioc	forest	2-3	10-15				
MOIST SEMI-DECIDUOUS AND DRY FOREST ZONE (including humid zone of derived savanna)									
West Africa	1500-2000	maize, manioc	moist semi-deciduous forest	2-4	6-12			25	
West Nile, Uganda	1400	elusine, sorghum, simsim, maize	grass, mainly Setaria spp.	2-3	8-15	3	3	18	Refers to "outside fields"
Abeokuta, Nigeria	about 1300		thicket			2	4-5	30	Soil derived from tertiary sand; evidence of nitrogen deficiency.
Ilesha, Nigeria	about 1300		thicket	2	6-7			24	Soil derived from granite.
Central Uganda	about 1300		elephant grass	3	8	1	2	27	
Ivory Coast	about 1300		elephant grass	3	3	9	6	50*	
Zambia	about 1300		thicket	6-12	6-12			50*	"Chipya" forest soil
SAVANNA ZONE									
Ivory Coast	1200		Imperata	2-3	6-10	2-3	4-6	24	
Uganda	about 1100		Andropogoneae	1	2½	1	< 2	28	
Northern Ghana	about 1100		Andropogoneae	3-4	7-10			29	
Mali	1000-1300		short bunch grass	3	12-15			18	
Zambia	about 1000		miombo woodland	2	up to 25			7	Pallid sandy soils

* Short fallow farming in our terminology Source: Nye and Greenland 1961:128 (Also quoted in Ruthenberg 1980:32-3)

Table 3 : Characteristics of some examples of shifting and short-fallow cultivation* (1977 to 1983 sources)

Type of cultivation	Location	Population density per km²	Rainfall (annual average in mm)	Main crops under shifting cultivation (and main other crops under other forms of cultivation)	Average cultivation period in years	Average fallow period in years	R value (approximate)	Source of data
Mostly shifting cultivation	IVORY COAST Central: Besumi region	54	1500–2000	yams, groundnuts, rice (coffee, cotton)	2–3	6	25–33	Lassailly-Jacob 1983
	LIBERIA populated coastal, central and upland savanna zone of NW	higher	2000 to 4500	upland rice, cassava, maize (perennial crops)	2	3–6	25–40	Appleton 1982 Carter 1982
	LIBERIA NW and SE high forest zones	lower				8–12	14–20	
	LIBERIA central:Bong country		1900	upland rice (swamp rice, garden plots)	1–3	4–20	9–33	Van Santen 1974 in Ruthenberg 1980
	MADAGASCAR Andasibe, East escarpment, high forest zone	20–40	1750	Upland rice, maize cassava (swamp rice, cloves, coffee)	2	5–20	9–29	Oxby 1983 and Boerboom
	MADAGASCAR Tsaramainandro, East coast, no high forest left	83	2000			3–6	25–40	

* Following Ruthenberg, shifting cultivation is characterized by an R value of less than 33, short fallow farming of between 33 and 66.

(Table 3 continued)

Mostly shifting cultivation	NIGERIA Kabba, Kwara State	n.a.	1125	yams (perennial crops)	4-5	26-29 15-17 6-12	14 22 33	Atteh 1980 in FAO 1984
	NIGERIA Ikale Ondo State	50-230		maize, yam and cassava (cocoa, oil palm)	2	5-10	15-29	P. Richards 1977
	SIERRA LEONE Southern, Moyambe District	16-32	2000	Upland rice cassava (swamp rice)	1-2	9	14	Johnny 1979 in FAO 1984
	SIERRA LEONE Eastern Province	50	2500-3000	Upland rice cassava (swamp rice, coffee, cocoa)	1-2	7-8	17	Land Resource Survey 1980 in Sierra Leone case study
	SIERRA LEONE adjacent part of northern and southern provinces	40-100	2500-3000	Upland rice (swamp rice, tobacco)	1-2	5-8	19	FAO/World Bank 1982
	TANZANIA Southern, Kilombero valley (altitude)	20-23	1200-1400	Upland rice, maize, cassava	3-5	10-20	21	Vieweg and Wilms 1978
	ZAMBIA northeast	n.a.	1000-1200	maize, beans	2	7	22	Lawton 1982
Short fallow cultivation	BENIN southern provinces	150	1000-1500	maize, cassava, yam (oil palm)	3	3	50	FAO/African Development Bank 1982
	TANZANIA Morogoro District (1400m altitude)	22	1500	cassava, maize, cocoyams, paddy, (coffee, bananas, pineapples)	2-5	3	50	Anandajayasekeram Moi, 1980, 1981, in FAO 1984

Of course, burning is blamed all the more in areas of wood shortage, as was the case around Antananarivo, the capital of the Merina Kingdom at that time. On the whole, anti-burning measures have met with little success, especially if they are introduced in the absence of any alternative method of clearing vegetation in a labour-saving way and enriching the soil.

Lassailly-Jacob (1982:88) explains the position of farmers in the Ivory Coast:

> "Sans brûlis, la terre ne pourrait être mise en valeur; les branches, troncs et débris seraient trop nombreux et gênants; le recrû forestier serait si vivace qu'il concurrencerait les espèces cultivées; de plus, sans brûlis, la minéralisation des matières organiques serait trop lente."

She argues that what is needed is advice to farmers on how to use fire and control it more efficiently, rather than fire prevention.

In order not to misunderstand the farmers' position on fire, several points should be borne in mind:

Beneficial aspects of burning: farmers would be likely to reject the view that burning is but a waste of vegetation, because they recognize the value of ash as fertilizer, and usually make a direct link between the amount of vegetation burned and the degree to which the ashes enrich the soil. Most of the fertility derives from burning the leaves as opposed to the stem, especially when it comes to food crops which require instant fertility; the stems may take some time to decompose and are therefore more important for longer term growth as with trees.

Moreover, the leaching effect from the burning of vegetation considerably increases the availability to plants of nutrients in the soil, according to Schmidt (1973:65). And fire may play an important role in removing foci of fungal diseases and noxious insects (Levingston, 1983). Also, burning of slash is generally a less arduous way of clearing woody vegetation than cutting and extracting it: unless a good deal of time is spent on further clearing and weeding, therefore, not burning would restrict the choice of crops which can overcome the competition of other plants and mature successfully.

Farmers often prefer clearing forest regrowth than high forest: farmers may avoid clearing high forest when they have the choice of clearing regrowth because of the high labour requirements of the former (see Ivory Coast case study). In Liberia, younger vegetation of 6 to 10 years is preferred especially if young men are not available to do the clearing work which is then left to women (Carter 1982:69). Consequently less valuable timber is being "wasted" than some may believe. Likewise in northeastern Zambia, since many of the able-bodied young men are away from the village working on the copperbelt, it is often not practical to clear the larger trees, and plots which have only been left to fallow for a short time may be preferred in order to facilitate clearing (Lawton 1982:293).

Farmers usually protect useful species from fire: it is sometimes believed that farmers are unable to manage fire successfully. On the contrary, there is every evidence that farmers are generally able to control fire if they want to and often take adequate precautions such as the clearing of firebreaks, or leaving the cleared vegetation to dry out before burning so that it burns more rapidly than the surrounding vegetation. In this way useful species are often protected from the damaging effects of fire.

In cases where demand for wood and other forest products is high and where communications, transport and markets are accessible, farmers commonly extract forest products before burning. For example, in the region of Andasibe, Madagascar, high forest is being cleared, but before burning, the larger trees are cut into lengths for railway sleepers, and much of the wood is made into charcoal for sale in the towns.

Fire is used by farmers for purposes not connected with shifting cultivation; it is also used by people other than farmers: thus Baoule immigrants moving into the forested areas of southwest Ivory Coast from the savanna areas to the north, in their search for land to clear for perennial crop plantations, make a greater use of fire than the local farmers who practise shifting cultivation (see Ivory Coast case study). In the wooded savannas fire may be used by hunters, to trap animals and by herders, to destroy parasites and encourage the regrowth of new grass. Forest fire is also a well-established form of protest or expression of discontent.

An example of the mistaken blaming of shifting cultivators for the uncontrolled destruction of forest by fire is provided by the recent Mozambique project assisted by FAO called "Slash-burning prevention". The following quotation is taken from a project progress report:

> ... "the constant reference to "slash-burning" is misleading and this may be due to difficulties in translation. ... An important finding, based on fairly extensive travel through three provinces said to be representative, is that fire from slash-burning (in this context, synonymous with "shifting cultivation") is not the main cause of uncontrolled fire."

This was subsequently confirmed to me by the departing project director (Mather, 1983).

2. SHIFTING CULTIVATION AND UNPLANNED* CHANGE

2.1 Introduction

2.1.1 Social change in Africa over the last few decades has been characterized by the following: increasing population densities; the expansion of areas under cultivation caused partly by increasing population densities but mainly by the introduction and expansion of cash cropping; the consequent increasingly difficult access to land; and the increasing participation of small communities in regional, national and international markets.

Changes in agricultural techniques can be understood in this framework: what one has been witnessing over the last few decades is a rapid intensification (compared to developments in many other parts of the world); agricultural techniques have been adapting fast (though in some places not quite fast enough) to the changing circumstances, in particular the increasingly difficult access to land.

2.1.2 Carrying capacity of shifting cultivation

Shifting cultivation is characterized by long periods of fallow and therefore requires a large amount of land per family, most of this resting fallow at any one time. It is simply not possible to practise shifting cultivation when population densities rise and there is not enough land to leave a satisfactory period of fallow. However, just how high is the population density which can be supported by shifting cultivation is a matter of some debate. Ruthenberg (1980:62) calculates that no more than 56 persons per square kilometre can be supported by shifting cultivation, assuming an even use of land, three crop years and 15 fallow years, 6 moves per cycle and 0.3 ha of crops per person.

Table 3 demonstrates a certain correlation between shifting cultivation and low population density. The example of Benin, with a relatively high R value of 50, is accordingly associated with a relatively high population density of 150 persons/km^2. On the other hand, the example of Tanzania, with the same R value of 50, is associated with a low population density of 22 persons/km^2: this can readily be explained by the

* Unplanned in the sense of "not planned by the government", or "spontaneous".

fact that much of this mountain area is not cultivable or inhabited. In other cases the presence of towns may distort the population density figures (see for example the case of Ikale in Nigeria). It is therefore important to distinguish between absolute population density and population density in relation to cultivable areas. When discussing the carrying capacity of shifting cultivation it is the latter figure which is crucial, but often difficult to obtain.

Lassailly-Jacob, in a detailed survey of land use in Beoumi, central Ivory Coast, estimates that only 60% of the land area is used for traditional food crop production (shifting cultivation, see table 3 for details); that the population density in relation to this area is as high as 83 inhabitants/km^2; and that the theoretical maximum number of persons who could live off shifting cultivation in this area without destroying the environmental balance is as much as 123 inhabitants/km^2. Her results challenge the common assumption that the Beoumi area is over-populated and more generally demonstrate that shifting cultivation can support a relatively high population density and should not be regarded as "dévoreur d'espace" (Lassailly-Jacob 1983:13).

2.2 Adjusting to changing conditions

The system of shifting cultivation called "citimene", as practised by the Bemba people of northeastern Zambia in the 1930s (Richards, 1939), relied on a fallow period of about 30 years and was practised in an area of extremely low population density: 3-4 inhabitants to 1 km^2. Nowadays, of course, this is no longer possible, and rather different techniques are now practised in the same area. There are many possible reactions to such changing circumstances in the rural areas. One of the most radical is rural exodus: the conditions no longer exist to produce such a good harvest with traditional methods of cultivation, and there are paid jobs available in the towns. Thus over the decades many Zambian farmers left their farms, temporarily or permanently, to become miners in the copperbelt region.

Another reaction is to adapt the agricultural techniques to the changing circumstances. Faced with land shortage, crop rotation practices are adapted (see for example Vermeer, 1970) in relation to Tiv farmers in Nigeria and Lassailly-Jacob, 1983, in relation to Baoule farmers in Ivory Coast), and the intensity of cultivation is increased by extending the cultivation period and/or decreasing the fallow period. Thus Lawton (1982:293) gives recent evidence from another part of northeastern Zambia: he states that 7-year-old growth of "miombo" woodland is being cut in some cases, whereas the traditional period of regeneration was about 25 years.

This strategy, however, is only rational up to a certain point, beyond which any further decreases in fallow period would result in soil degradation and decreasing yields. At this stage, a more radical change has to be made from fallow agriculture to permanent agriculture for example. Typically, the farmer introduces this change at first only on some of his plots, whilst leaving the rest under fallow farming. Boserup gives the example of short fallow farmers in a situation of growing population density and increasing land pressure:

> "A growing rural population does not produce additional food by increasing the number of times the land is ploughed or by the weeding of fields under short-fallow cultivation which were hitherto left unweeded. Instead of such changes, which would not add much to total output, short-fallow cultivators are likely to take to annual cropping on a part of their land. This transition in its turn may call for the introduction of better ploughing, irrigation and weeding - or the shortening of fallow may have as its necessary concomitant the production of fodder crops for the animals. In other words, the additional labour is likely to be used as a means to undertake a radical change of the system of cultivation in part of the area, while no change is made in other parts of the area."
> (Boserup 1965:26)

The plots which undergo this change to permanent agriculture first are usually those nearest the house site; animal, vegetable and general household refuse are used to fertilize gardens around the house, where all sorts of vegetables, root crops and fruit trees are grown. And, together with more permanent forms of cultivation go more permanent forms of housing.

2.3 Failing to adjust: deteriorating farming conditions and yields

The main purpose of the fallow period in shifting cultivation is simultaneously to improve soil fertility and the soil's capacity of resistance to erosion (Jean 1975, quoting Centre Technique Forestier Tropical, Paris). There is evidence that the length of fallow period can be decreased to a certain extent without seriously compromising these functions:

> "Des recherches à la station expérimentale de Yangambi au coeur de la forêt près de Kisangani, montrent que plus de la moitié des substances nutritives les plus importantes s'accumulent (dans le sol) durant les cinq premières années d'une jachère de 18 à 19 ans." (Jean 1975:35 quoting Miracle 1967).

The actual length of time obviously depends on a variety of factors, such as soil type, vegetation type, and intensity of previous cultivation of the area. Another factor is weed control: in wetter climates, to prolong the period of cultivation implies the need to apply more sophisticated weed management techniques or to spend more time on this work. However, it is clear that beyond a certain point further decreases in fallow length and/or further increases in cultivation length prevent the fallow from accomplishing its functions. Shifting cultivation, from balanced exploitation becomes "soil mining", as illustrated in Figure 2.

Given the increasing cultivation period and/or decreasing fallow period consistent with increasing land pressure, at a certain stage yields can only be maintained or increased by the use of fertilizer. This principle is the basis of Jean's (1975:12) division of cultivation techniques into three types:

1. temporary cultivation with fallow;
2. semi-permanent cultivation with fallow and fertilizer;
3. permanent cultivation with fertilizer.

It can readily be seen that the transition from 1 to 2 and 3 depends upon access to fertilizer. If chemical fertilizers are too expensive or not available; if animals are not kept so that manure is unavailable; if the use of "green manure" is found to be too labour intensive, and so on, then there is a likelihood that increasing land pressure will result in soil degradation.

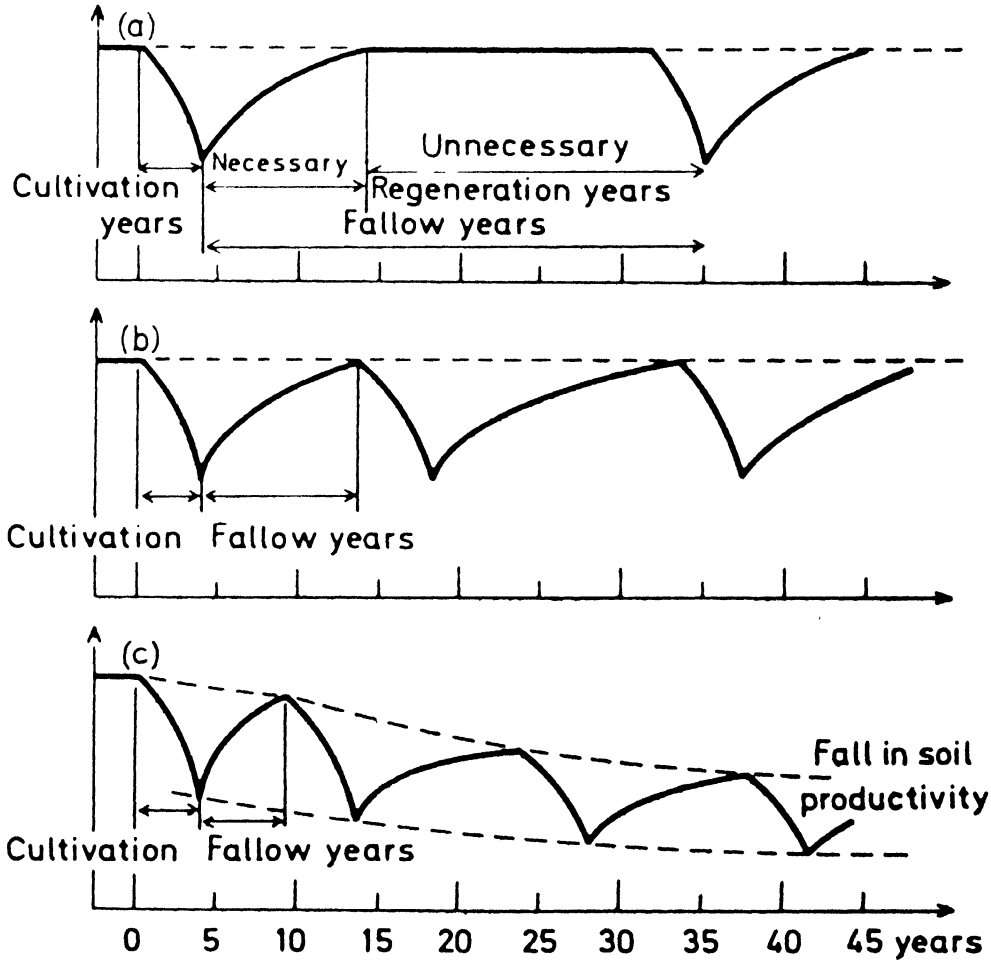
If yields continue to decline under these circumstances, members of the farming households may look for paid jobs to contribute to family income; or some or all of the family members may migrate to another area where land pressure is not so great. It has been a subject of much discussion why farmers resist change until the process of decreasing yields and soil degradation have, often irreversibly, set in. Why can they not change before this process begins, it is often asked. Several suggestions are put forward here, some of which may apply to some areas and not to others:

a) It has been demonstrated that the more intensive the agricultural technique, excluding mechanization, the worse the returns to labour (Boserup 1965:32-3 and other authors since). Thus a change from upland rice under shifting cultivation to swamp rice under permanent cultivation generally represents an increased labour requirement (see Sierra Leone case study).

b) In cases of soil degradation it is often discovered that the farmers concerned have no long-term security of land tenure; in other words, they will not necessarily benefit from soil conservation measures: their landlords will.

c) Switching to a new agricultural technique represents a risk which may be unacceptable to farmers who only just manage to satisfy their subsistence requirements. Such farmers will wait until others have tried and succeeded before they themselves try.

Figure 2: The relation between length of fallow and soil productivity in shifting cultivation.
(Source : Ruthenberg 1980:62 from Guillemin 1956).



"The yield of the soil drops with the number of cultivation years and recovers in the fallow period. In (a) the fallow period lasts longer than the regeneration of the soil requires. R is low (11). This is shifting cultivation with production reserves. The situation in (b) corresponds to that of shifting cultivation without production reserves (R=29). The fallow period is, however, long enough to restore soil fertility to its original level. (c) shows what happens as the fallow is shortened (R=46). The fallow is no longer sufficient to restore soil productivity and the yields per hectare fall, though since the shortening of the fallow period means that a greater part of the total area is cultivated, the fall in yields per hectare may well be accompanied by a rising total production. However, the result is a continuous degrading process."
(Ruthenberg 1980:62)

d) Switching to a new agricultural technique may require capital investments which the small farmer cannot afford, or which are difficult to obtain locally (fertilizer, improved seeds, etc.).

e) Making the new agricultural technique profitable to the small farmers may depend on easy access to markets, and access to transport. In some areas such conditions may not exist.

To illustrate this process, P. Richards describes the deteriorating conditions in which farmers in the Ikale region of Southwestern Nigeria have been farming, in particular the decreasing land available per farmer over the years. Figure 3 shows that this trend is particularly important in the case of two of the Ikale Districts, Orisunmeta and Idapomarun, which between 1952 and 1963 experienced population growth at the rate of 7.41 and 6.98 percent respectively (rather than the 2.5 or 3.0 percent characteristic of other parts of Africa over that period).

> "The conclusion is that although shifting cultivation may survive in Idapometa district for some years to come, something of a crisis in man-land relations is developing in both Idapomarun and Orisunmeta districts. Pressure on land has already led to far-reaching changes in the agricultural economy, but there can be little doubt that further change is called for.
>
> There are four probable directions in which such changes may occur. First, evolution towards permanent cultivation of annual crops must almost certainly take place, perhaps via a "compound land" farming system as practised in parts of eastern Nigeria. In this respect it is of interest to note that some of the best yams are to be seen growing right in the heart of settlements, immediately around the houses. These domestic "gardens", especially prominent in the farm-camps and smaller villages, are in most cases deliberately manured and farmers are aware of the nature and significance of the yields they get from such sites.
>
> Secondly, there is likely to be continued increase in the acreage planted to tree crops, especially oil-palm. This is an understandable if not entirely satisfactory development since tree-crop plantations provide an assured cash income, are much less prodigal of land, and once established require less labour to maintain than annual-crop farms.
>
> Thirdly the number of farmers engaged in part-time trade and manufacturing and in plantation labour will continue to grow. The three government-sponsored oil-palm estates at Ilutitun, Igbotako and Ikoya, will continue to attract local labour, while the associated oil-palm mill in Okitipupa will provide an additional incentive for the development of peasant oil-palm plantations. Finally, the pressure of people on land remaining unabsorbed by these three kinds of changes will continue to seek an outlet in that long-established standby of an underoccupied rural labour force, migration - especially migration to the major urban areas."
>
> (Richards 1977:78-9)

2.4 The last resort: migration

Apart from rural-urban migrations, which are a constant feature of areas of land shortage, there is a less obvious but equally important type of migration: that of farmers from areas of higher population density into neighbouring rural areas of lower population density. Such migrations vary according to the distance travelled and the extent to which the agriculture practised in the homeland differs from that practised in the new lands. In some cases such migrations represent an attempt to find farming conditions comparable with what was found in the past in the homeland.

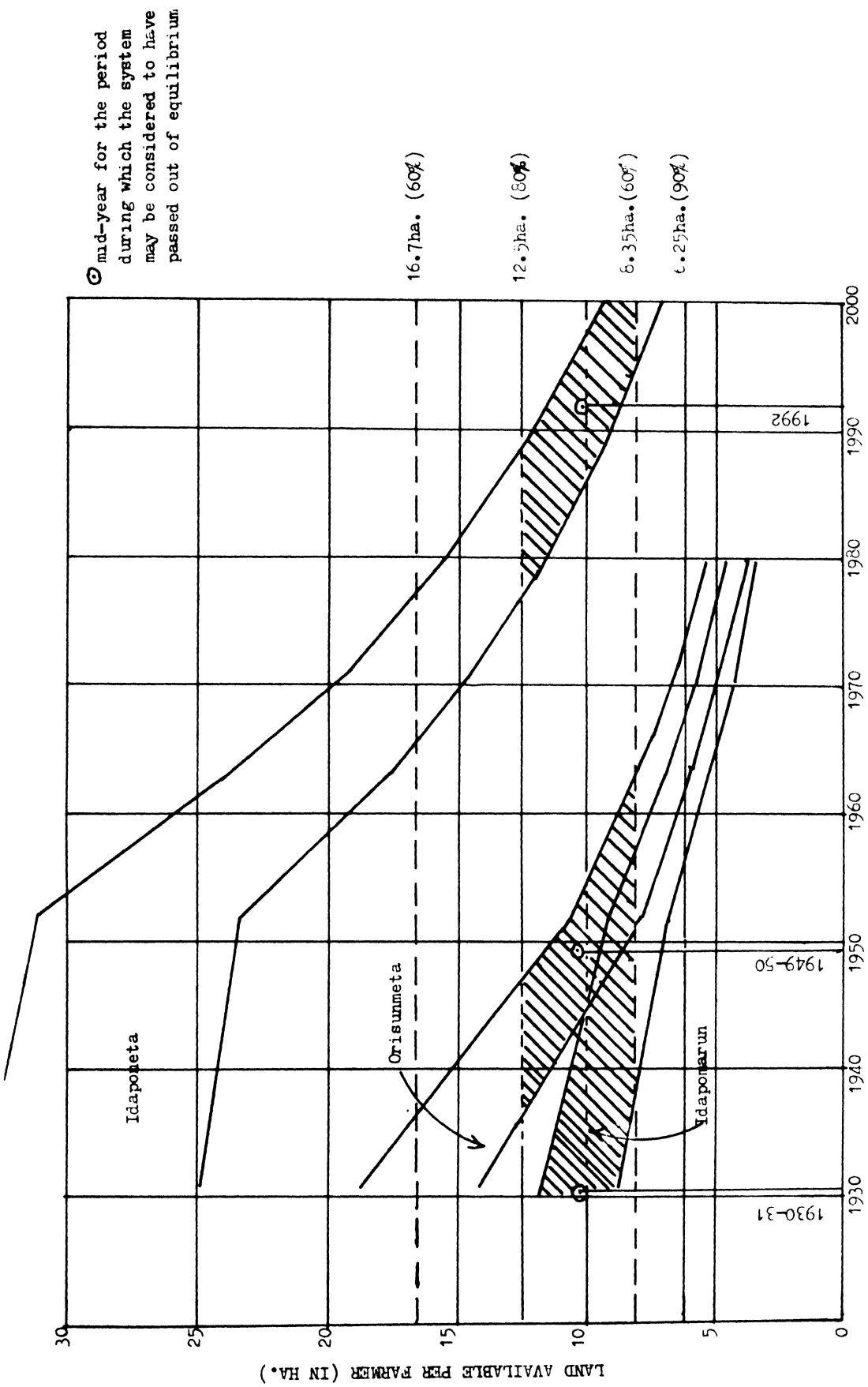


Figure 3 : Graph of land available for fallow farming in three districts near Ikale, Western Nigeria, with increase of population over time

In situations of change, it would therefore be inaccurate to think that farming systems were adapted only in the direction of intensification of agriculture. They usually are, and this is consistent with the prevailing trends towards increasing population density and increasingly difficult access to land. But this is by no means always the case: where people move from an area of higher population density to one of lower population density and easier access to land, this may be accompanied by an extensification of agriculture. Boserup (1965:63) gives as an example the European (especially German and Italian) colonizers in south Brazil, who descended in the technological scale rather than ascended, when they met with rather different conditions in the country they came to from the one they left.

Likewise Richards (1939:289) says that it was difficult to find out how long the Bemba of Zambia had followed their practice of shifting cultivation, "citemene", involving only an axe to cut down branches, and why they differed from kindred peoples in this respect. Some of her informants told her that they only learned it when they arrived in this particular locality; before that they were in an adjacent territory, Lubaland, and the Bemba "hoed like the other people" when they were still there.

A more recent example of extensification of agriculture through migration is provided by seasonal migrants in the east of Nigeria, who travel from areas of high population density in Iboland (e.g. Udoka Court area of the Awka Upland and Eseagu County of Udi Plateau) to adjacent areas of lower population density (e.g. Nikeland north of Enugu), anything from about 20 to 100 km away (Grossman 1974:205). According to this author, at least one third of the population of northern Iboland is affected by this form of migration. Most migrants live in camps consisting on average of 30 households. They spend 6 to 9 months in the camps, but retain their permanent home bases, paying periodic home visits whose frequency depends on the distance between farm and village. The migrants take out yearly leases with the local land owners (payment sometimes in kind in the remoter areas, but usually in cash) which are usually renewed on expiry. The migrants farm food crops exclusively (especially yams in the first year, followed by cassava in the second, then a bush fallow for 3 to 6 years) and the exclusion of economic trees is almost invariably specified in the tenancy agreements; or else the landlords permit planting of trees but insist that ownership reverts to them after expiry of the lease.

Another example of migration from areas of higher to lower population densities is the important migration route into the humid forest zones of West Africa from the subhumid and sahelian zones to the north. Until recently the southern forest zones were inhabited mainly by low densities of farmers practising shifting cultivation. Many of these forest have been opened up by roads constructed by logging companies in connection with the selective harvesting of timber. Rapid changes in land use were observed during the 1940s, 1950s and 1960s in Ghana, when much of the forest in the south of the country was turned over to the cultivation of cocoa. (For a description of this process from the samll-holder's point of view, see Hill 1963). A similar process occurred in neighbouring Ivory Coast with both large-scale and smallholder plantations of coffee, cocoa and oil palm. In addition to the local farmers, large numbers of other people were attracted to these areas by the availability of unskilled paid jobs with the timber companies and on the state plantations. In accordance with the patterns of labour migration in West Africa, these labourers mostly came from the north: in the case of southwest Ivory Coast, from the savanna zones just north of the forest (especially Baoule people from the region of Bouaké) and from further north, even as far as the Sahel (especially Mossi people from Upper Volta).

Such migrations and changes in land use patterns have of course had profound consequences on the local farmers. Following the example of large-scale private and state perennial cash crop plantations in which they provided much of the labour force, many of them have turned to permanent cultivation of perennial cash crops in addition to their subsistence farming. This suggests that the lack of roads and access to markets was an important factor in determining the local people's way of life as subsistence farmers; and that as soon as conditions changed and they had access to markets, they switched to a way of life which was more profitable to them.

The migrant farmers have sometimes been confused with the local farmers and misleadingly called shifting cultivators.* In fact, a substantital difference in land use patterns can be observed between the local farmers and the immigrant farmers. Rouw (1979; this work is summarized in the Ivory Coast case study) compared the cultivation practices of Oubi local farmers and Baoule immigrant farmers in the southwest of Ivory Coast. She found differences in food crops grown: the Baoule grow mainly yams, the Oubi mainly hill rice. She found differences in cultivation techniques: the Baoule have a greater use of fire in land preparation than the Oubi; the Baoule, coming from savannah areas, are not used to the axe, but cut trees with a machette and prepare yam mounds with a hoe; whereas the Oubi use the forest farmer's traditional tool, the axe. But most strikingly, the great majority of the land which is cleared by the Baoule farmers is subsequently planted with coffee or cocoa. They do not use fallows for the regeneration of soil fertility. They practise permanent, not shifting, cultivation with food crops in the early years of plantation establishment. The local farmers, on the other hand, continue practising shifting cultivation of food crops on some of their land with an average of one to two years' cultivation followed by three to four years fallow period; and on other parts of their land they have switched to the permanent cultivation of tree crops with food crops during the first year of plantation establishment.

One consequence of this change in land use from shifting cultivation to perennial cash crops is that the more forest land is cleared for plantations, the less is available for agriculture (this also is one of the problems encountered when establishing forest plantations by the "taungya" system, and caused a lot of farmers to resent the system). The local farmers are likely to suffer most in the long run, since when their land runs out, they have nowhere to go. Whereas the Baoule immigrants firstly usually retain links with family in their area of origin, some of whom will be farming food crops there; secondly, they have moved at least once and will probably find it easier to more again than the local farmers, many of whom have no experience of other areas. Thus land for food crop cultivation is becoming scarce in some areas of SW Ivory Coast which have experienced a rush of tree crop plantation. To quote the title of a recent publication on the same subject and the same area (Ruf 1982); "Ma forêt est finie. Où planter l'igname?". Land scarcity has brought on conflicts between local and immigrant farmers, which are at the root of arson attacks whereby cocoa and coffee plantations are maliciously burned (Fraternité Matin Ivory Coast newspaper article of 18 March 1983, p. 10).

3. SHIFTING CULTIVATION AND PLANNED CHANGE

It would be quite wrong to think that shifting cultivation in all its forms was an unsatisfactory form of land use. Okigbo (1981:41) states that bush fallow systems can be stable, ecologically sound and efficient farming and land use system; and Nye and Greenland (1960) argue that until now we have failed to evolve a superior method of staple food cultivation in the tropics. It should be stressed that problems of land scarcity, population pressure, soil degradation and decreasing yields are associated not so much with shifting cultivation but more with short fallow cultivation in areas where shifting cultivation was once practised, but where conditions have changed so that it is no longer possible to leave a long fallow period, and where the fertilizer and other inputs needed for a more intensive land use are too expensive or not available.

* If the term shifting cultivation has been mistakenly applied to these migrants it is because they plant food crops in the early years of plantation establishment. The term is inappropriate because food crops are only tolerated as long as they do not rival the perennial agricultural crop species, and the latter is not grown in order to regenerate soil fertility for food crop production.

Priority planning effort should therefore be addressed to these "crisis" areas of short fallow cultivation; not to areas where it is still possible to restore soil fertility and forest vegetation by sufficiently long periods of fallow. One type of planning effort concerns the improvement of fallow cultivation; the other concerns its replacement by other forms of cultivation. These will be treated in turn. In both cases the role of trees (forest or agricultural crop) is of utmost importance. This is because it is widely recognized that planted trees, in the same way as trees which grow naturally in the fallow, can play a crucial role in controlling erosion, suppressing and eliminating herbaceous and woody weeds and in restoring soil fertility (Grinnell 1975:21). Alternatives to fallow cultivation which have involved complete land clearance including destumping and a change to other forms of agriculture without trees, for example annual crops, have often not been successful (see Senegal case study).

3.1 Improvements to shifting cultivation

3.1.1 Regulating the fallow period: the "couloir" or corridor system

Jurion and Henry (1967) and Tondeur (in FAO 1956) describe the efforts practised in the then Belgian Congo to regulate shifting cultivation by delimiting strips of land which were to be cleared then left fallow according to an overall plan for a particular area (see Figure 4). These efforts failed for a variety of reasons (see Ruthenberg 1980:65). On the technical side, such a regular division of the land meant that it was impossible to respect the different needs, in terms of fallow years especially, of different parts of the land: in other words, some patches of land would be ready for recultivation before the appropriate time in the cycle. On the socio-economic side, these efforts lacked farmer cooperation. On the contrary, many farmers were forced to come to the new villages (called "paysannats") associated with this scheme. Since the farmers were obliged to grow a certain amount of cash crops like oil-palm, they saw these changes more as a method of social control, tax collection and cash crop extraction, than as a method of improving their agricultural techniques (Baya-Vuma, 1983).

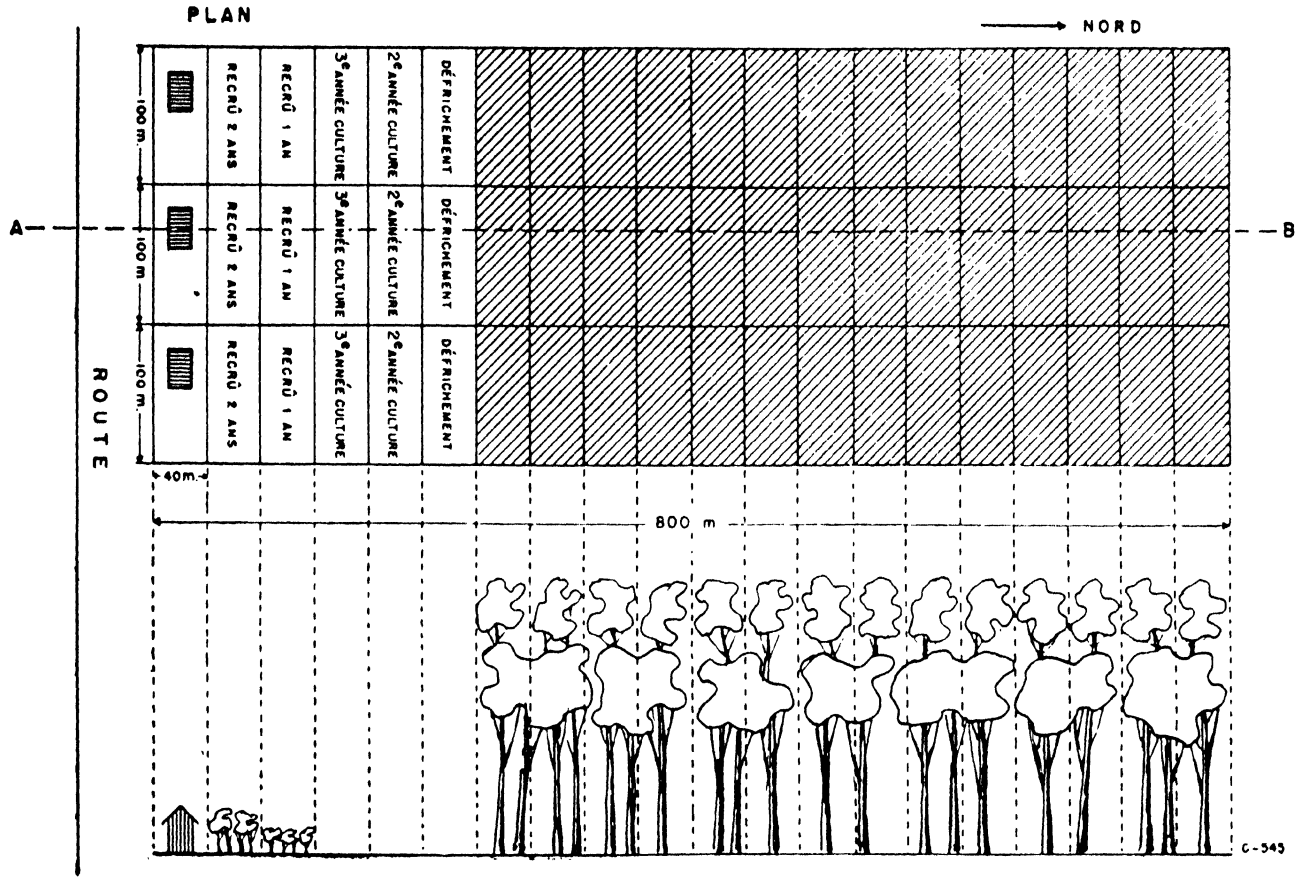
3.1.2 Planting trees and grasses in the fallow in order to regenerate soil fertility in a shorter period of time

The practice of substituting artificially established woody legumes for natural bush fallow vegetation is an old idea of proven value for edible varieties of pigeon pea, but the potential of the technique for other woody legumes which yield firewood and other by-products, while at the same time contributing to the restoration of soil fertility, has yet to be explored (Raintree 1981:115).

Let us mention in passing one example, from the Ibo heartland (Awgu and Nsukka Divisions) of farmers who, according to Grossman (1974:206), plant "Acioa barteri" 1/ a coppicing shrub but not a legume, in order to shorten the fallow period. Nevertheless the point is taken that there are many more trees and shrubs which, if planted in the fallow, could help to increase the speed at which sufficient soil fertility is re-established in order to plant the next agricultural crop.

1/ Acioa barteri is a fast-growing, shrub capable of growing in dense stands, evergreen, useful for green firebreaks, yam sticks, tomato stakes and possibly fuelwood. It is sometimes planted, and is found from Sierra Leone to Nigeria, also in Zaire (R. Levingston, 1983).

Figure 4: The "couloir" or corridor system of regulating cultivation and fallow periods



"Recru" : forest regrowth
"Culture" : cropping
"Défrichement" : clearing
"an" or "année": year
"route" : road

Raintree also lists the desirable characteristics of species for planting in fallows, followed by the species which appear to conform most closely to at least some of these characteristics:

Characteristics of ideal species

1. High N-fixation capacity
2. Fast growing
3. Capable of restoring soil fertility and suppressing weeds in a shorter time than natural bush fallow
4. Able to provide good erosion control
5. Easy to establish rapidly and economically
6. Easy to harvest
7. By-product yields provide significant additional economic incentive (e.g. food, forage, firewood, fibre, building materials, staking, etc.)
8. Special adaptive characteristics (e.g. promiscuous nodulation; tolerance of drought, acid soils, high altitudes, cultural acceptability, history of previous local use, etc.).

Some promising woody legume species/genera for trial and evaluation

	Habit
Acacia auriculiformis	tree
Albizia falcataria	tree
Cajanus cajan	shrub
Calliandra callothyrsus	small tree
Cassia spp.	tree
Crotolaria juncea	shrub
Desmanthus spp.	shrub
Desmodium spp.	shrub
Enterolobium cyclocarpum	tree
Leucaena leucocephala	shrub/tree
Mimosa scabrella	tree
Sesbania grandiflora	tree
Tephrosia candida	shrub

(Source: Raintree 1980:115).

Although a number of projects and field trials are being carried out in several countries, there is as yet little information on the implementation of planting in fallows, and the acceptance of the principle by farmers.

In Madagascar, the project "Restauration et mise en valeur des 'savoka'" (see Appendix and Madagascar case study), concerns in principle the rehabilitation of the vegetation, called 'savoka' which grows during the fallow period after the cultivation of hill rice and other associated crops (maize, beans). The planting of "Grevillea" in "savoka" was tested with the trees growing in the fallow for three years, then being cut for fuelwood when the "savoka" was cleared for rice cultivation. Better yields of rice were obtained than on similar lands left fallow for three years without "Grevillea". (Bé, 1983).

In Benin, a government programme has encouraged small farmers to plant Acacia auriculiformis in their fallow land in order to enrich the soil with nitrogen and humus and at the same time produce fuelwood quickly (see Appendix). By 1982 some 200 000 saplings had been produced for distribution by local organizations. However, they have not all been planted, because the farmers have not yet appreciated the soil-enriching properties of the tree (the programme only started in 1980), and they prefer to plant Tectona (teak) and Eucalyptus because their stems are straighter for poles and also the leaves of the latter are appreciated for their medicinal qualities.

A major problem with this scheme is that the length of the fallow period is gradually being reduced and it is now three years, sometimes even two years. The land shortage is acute, and the population density increasing rapidly, so the trend of shortening fallows is continuing. Three year old Acacia can still produce about 7 m^3 of fuelwood per ha per year, but if cut before that time, the full advantages of planting Acacia, in particular those related to regeneration of soil fertility, would not be felt. On the other hand, it is impossible to persuade the farmers to leave the land fallow for longer since they need it to plant food crops for their own subsistence needs.

The long-term aim of the project is that the farmers should transfer from a distribution of fallow between fields (fallow years follow cultivation years) to a distribution of fallow within each field (some parts of the land are in fallow while others are being cultivated): Acacia would be planted in rows, with food crops between them and a rotation organized whereby crops would be grown on soil enriched by the Acacia. However, the lack of opportunities for marketing surplus produce is a major disincentive to the intensification of agriculture in this area (Tran Van Nao, 1983). Such agroforestry techniques will be discussed fully in a later section.

3.1.3 Making better use of cleared vegetation: The Subri Conversion Technique

The assumption - as we have seen, partly misleading - that burning vegetation is wasteful is at the basis of a number of attempts at improving shifting cultivation by replacing fire with other techniques of clearing. One such attempt has been named the "Subri Conversion Technique", after the Subri Forest Reserve in Ghana where it was developed (see Appendix and Ghana case study). It is a technique for clearing forest without burning and with the maximum use of the cut vegetation: most of it is to be extracted as sawn lumber, some as charcoal, some as fuelwood, and some for small local industries like carving and basket weaving; and the remainder, the small branches and leaves, are to be used as green mulch for the agricultural crop.

Although field trials have already been carried out within the forest reserve and results made known (see Earl 1982), no effort has yet been made to introduce the technique to farmers outside the reserve. Those farmers employed as labourers within the reserve, however, will have had an opportunity of observing the new practices. The field trials indicate that income from the Subri Conversion Technique exceeds expenditure by about US$ 831 per ha before taking into account food production and the benefits derived by private entrepreneurs. Table 4 indicates the product and its value on site per ha, and gives details of arrangements made with charcoal entrepreneurs.

Subri Conversion Technique
Output and value of product on site for 1 ha of a 100- ha programme

Product	Amount	Unit Value US$/$m^3$	Total Value US$
Sawn lumber 1/	5.8 m^3	655	3799.00
Charcoal 2/	4.0 m^3	600	2400.00
Fuelwood	50 m^3 (piled)	17	850.00
Grand Total			7049.00

1/ 15.3 m^3 at 38%
2/ Entrepreneurs pay 4t (40% of product) to the project. The remaining 6t (60%) is marketed by themselves and represents an additional benefit to the economy.

Source: Earl 1982:23.

On the other hand, the direct costs of the Technique are about 2.9 times those of the ordinary cut-and-burn technique and require about 37 per cent more labour (Earl 1982:23). These last two facts probably mean that to the small farmer with limited capital and limited labour resources, the new technique is not a feasible proposition. Moreover, the trials comparing the Subri Conversion Technique with the cut-and-burn technique have taken into account forest tree production, but not agricultural crop production (see Table 4 above), which is, of course, what the farmers are primarily interested in.

Finally, since the land has been used very differently inside and outside the Subri Reserve, the vegetation to be cleared is also rather different. Therefore, results of trials in high forest areas inside the reserve may not be applicable outside the reserve, where there is no high forest left, and where vegetation is being cut after only a few years' growth. For all these reasons, one may expect farmers to have a cautious outlook in relation to any technique of clearing without burning, unless of course the farmers themselves are to make significant profits, for example from increased sale of charcoal, timber or food crops.

3.2 Alternatives to shifting cultivation

3.2.1 Cultivation of food crops in the early years of a Forestry Department plantation: "individual taungya"

Taungya is a word of Burmese origin (taung = hill, ya = cultivation, see King 1968:6) designating a system of large-scale forest plantation establishment used by Forestry Departments, in which food crops are interplanted between trees in the early years of plantation establishment. Two broad types of 'taungya' are distinguished, according to the farmer's role:

a) "individual taungya" or "own your own crop" (Olawoye 1975:229) (also known as "traditional taungya" or "private taungya"), where the farmer plants trees in return for use of the land for a limited period of time;

b) "departmental taungya" or "farming for pay" (also known as "direct taungya") in which the farmer carries out jobs for the forestry department, related to plantation establishment and agricultural crop production, in return for a wage.

None of the documents seen makes any reference to the fact that farmers may be practising "individual taungya" as an alternative to, or alongside, shifting cultivation. However, examples of "individual taungya" exist in humid areas of West Africa where shifting cultivation has been and still is practised today by farmers on some of their fields. In such cases, taungya appears to be, if not an alternative to shifting cultivation, at least a parallel additional system.

There are many accounts of profitability of taungya from the point of view of Forestry Departments which practise it to this day in order to establish plantations at low cost (see, for example, the cost/benefit analysis of taungya proposals for Sierra Leone in FAO/World Bank, 1982). There are, on the other hand, relatively few accounts of how profitable or acceptable taungya is from the farmer's point of view.

Under a system of "individual taungya", farmers are given access to plots of land in which they must plant trees which are the property of the Forestry Department. In return they may cultivate the spaces between the trees with food crops, the produce of which is their own. Depending on the crops and trees grown, and the Forestry Department regulations, the farmer may cultivate the land with certain prescribed crops for between one and three years, after which time the trees will have grown enough to shade out any food crops. At this point the farmer has no choice but to move to another area. If the Forestry Department is continuing to plant trees in the same way at this time, and if the Department is pleased with the way the farmer has looked after the saplings, then he may be offered another plot for use. If not, he will have to search for land elsewhere.

As an alternative to shifting cultivation, this is likely to represent a move from greater security of land tenure to lesser security for those farmers accustomed to cultivation outside forest reserves where they have permanent customary rights in land. Under "taungya" the land most definitely belongs to the State since it is part of the forest reserve. The farmer who is allocated one plot after the other by the Forestry Department can have a certain illusion of security of land tenure; however, in practice, departments do not continue their reforestation programmes year after year, and there always comes a time when no more land is available for "taungya". Also, there may not be enough land in forest reserve for everyone who would like access to it, so some farmers have to do without.

Since the farmer has no long-term rights to this permanent forest estate, there must be short-term incentives. One of these is access to cultivable land where such land is scarce. Indeed, it has been pointed out that the successful working of "taungya" is associated with a shortage of land suitable for agriculture (see King 1968:57). Ball and Umeh (1981:12) refine this by saying that the desire to farm on forest land is not necessarily caused merely by a shortage of agricultural land but by a shortage of fertile agricultural land - the forest land being seen as particularly fertile. Indeed Ball and Umeh state that "taungya" has not succeeded where there is available fertile agricultural land. The other short-term interest is, of course, the one to three years' agricultural crop. But since the crop under the "taungya" system is much reduced in relation to the area cleared, on account of the space and labour spent on the saplings, it is clear that the farmer would only choose this system if he could not otherwise get access to similar land.

Because of these factors, it is understandable that the Forestry Departments have had problems in their attempts to smoothly administer the "taungya" system of reforestation. In Togo, new "taungya" regulations introduced in 1958 (see Appendix) for grouping plots rather than allowing them to be dispersed as previously, triggered off a wave of protests against the "taungya" system, in particular the restriction on which crops to grow, and against the very principle of setting aside forest reserves: farmers resented the fact that they were being deprived of forest land to which they felt they had inalienable customary rights. There resulted a 'massive and uncontrollable invasion of the forests by the traditional custodians, who went as far as planting forbidden crops - oil palms, coffee, cocoa, etc.' (Nadjombe 1982:71). In the early days of independence, therefore, the "taungya" system was suspended.

In 1972 "taungya" was reintroduced in Togo with FAO assistance (see Appendix), but this time with added incentives in the form of bonuses in cash and in kind. However, two problems were faced: first, the farmers objected to the fact that it was not possible to carry out crop rotations; and second, the plantations were far from human settlements. Since there was no shortage of grasslands around the forest reserves and nearer the settlements, the plantations were gradually deserted in favour of the less fertile agricultural land. Once more the "taungya" system was disbanded. The next experiment in Togo was in "departmental taungya" (see below).

In Nigeria, three types of bonuses were being considered in 1981 in order to make "taungya" more attractive to farmers: subsidized food (obtained from "departmental taungya"); assistance with land clearing, crop processing and crop storage; and cash bonuses for successfully planted trees (Ball and Umeh 1981:9, 12). However, it remains doubtful to what extent even such bonuses can remedy the situation.

In Ghana, "individual taungya" was introduced in 1928, in order to satisfy the farmers' demand for cultivable land in areas of land shortage, and the foresters' demand for establishing a tree crop at reduced cost: the farmer bore the cost of the major item of expenditure in plantation management: site clearing. According to Brookman-Amissah (1978:4), "it cannot be said that success was commensurate with effort", since, as in Togo, the early plots were small, scattered, not too easily accessible, and did not constitute manageable plantation units. Moreover, tending of the tree crop was inadequate, especially after the farmer had left the site.

In 1968 the afforestation effort in Ghana was intensified (see Appendix), which meant a sudden increase in the amount of land which was available to the "taungya" farmer, "perhaps more than he really needed for his subsistence agriculture or could cope with. Since genuine land hunger is seen by many as one of the prerequisites for a successful "taungya" system, it is easy to visualize the forester's difficulty to get from the farmer his best performance. One may therefore say that from that day the forester, in these large afforestation areas, ceased to be the benefactor who dished out portions of his forest estate to the land hungry farmer and became very dependent on the farmer's goodwill for the establishment of his tree crop at low cost." (Brookman-Amissah 1978:4).

The sudden increase in land available for "taungya" created a situation in which some entrepreneurs found the large tracts suitable for commercial farming (ibid p. 6): "taungya" was being used by big farmers, and small farmers were being overlooked. In order to manage a situation which was getting out of control, in particular "to obviate the problems posed by over-abundance of land to the farmers", the Forestry Department introduced a system of "departmental taungya" in 1969.

In Liberia an alternative way of controlling the amount of land available to each "taungya" farmer was introduced by the Forestry Development Authority (FDA) in 1974 (see Appendix): land preparation up to, and including, the phase of burning is carried out by the FDA, and then farmers come in and plant one rice crop at a nominal fee of US$ 20 per acre. "The fee is charged to control the acreage given to each household and to help retain part of the cost for land preparation" (Appleton 1982:8). This system can be seen as part of the way between "individual" and "departmental" "taungya", but has been classed with the former since the farmer retains the use of the agricultural crop. Only 1,400 acres, capable of accommodating 400 households, are reafforested annually. The main benefits are reported as "reduction in the cost of reafforestation as farmers perform the initial task of tending the plantations. Increase in the production of upland rice through increase in cultivated acreage and improved seeds". (Appleton 1982:9). From the farmer's point of view, this system looks more like a yearly tenancy.

In Sierra Leone there are two variants on "individual taungya" (one, unfortunately, only at the stage of a proposal, and the other at an early stage of implementation) which have particular implications for the farmer. The first (Appendix Sierra Leone 2) is similar to the Liberian example just cited in that farmers would pay an annual rent for access to the land (though it is not clear whether farmers would be helped in clearing the land). The difference with any other "taungya" systems considered here is that the agricultural crops are not annuals, but perennials such as coffee, cocoa and cola, as understoreys in Terminalia ivorensis and Terminalia superba plantations. Providing that the arrangement could be renewed, this system would provide the farmers with a tenancy arrangement for at least twenty years, or as long as the life of the particular crop. This would provide a great deal more security of tenure than the one or two years "squatting" arrangement under "taungya" with annual food crops.

It was introduced in response to a situation where it became increasingly difficult for government to obtain additional land for forest plantations or even to retain the existing forest estate, because of a growing feeling in the country that landowners who had given up land for forest reserves and protected forests generally did not receive adequate or immediate compensation (Koroma 1982:69). The government has thus been encouraged to consider the farmers' desire for increased land security.

The second variant on "individual taungya" (Appendix Sierra Leone 3) is a proposal for community fuelwood plantations and community forestry plantations, to be established by farmers under the "taungya" system. Farmers, however, would benefit not only from the food crops planted in the early years of establishment, but also from the forest trees: it is clearly stated that "There should be no equivocation at any time as to which party would benefit from the sale of fuelwood or poles arising out of a farmer's operations under the "taungya" system. In this connection, the mission would expect the

farmers to be allowed to keep the proceeds of any harvesting of such material that he undertakes, subject perhaps to payment of a small license fee." (FAO/World Bank 1982 Ann. 1, p. 19).

It is precisely because the farmer is to profit from the forest trees that the project is called "community forestry"; and it is for the same reason that the word "taungya" is inappropriate, since a characteristic of "taungya" systems is that the farmers do not profit from the forest trees. Here, the term agroforestry would be more appropriate: the farmer himself is combining the production of agricultural crops and forest trees, both to be managed by him for his own profit. In this way the farmer is highly motivated to care for both crops, not just the agricultural crops as under "individual taungya", or neither, as under the system of "departmental taungya".

3.2.2 Paid Labour: "departmental taungya"

"Departmental taungya" is distinguished from "individual taungya" by the fact that produce from the agricultural crop planted in the early years of plantation establishment belongs to the Forestry Department, which rewards the agricultural worker with a wage. From the worker's point of view, therefore, "departmental taungya" is similar to other types of agricultural paid labour and radically different from "individual taungya": under the latter system, the farmer depends on his food crop for subsistence and is therefore highly motivated to take care in growing it, whereas under the former system, the paid labourer is only motivated to the extent that he will continue to receive his wage at the end of his work. It is therefore not surprising that Forestry Departments complain of 'lack of discipline' among their "taungya" labourers and that administrative costs are high. In Togo, the cost to the State of the food crop production under Forestry Department supervision 'exceeds acceptable limits' (Nadjombe 1982:7).

If and when the system of "departmental taungya" runs smoothly without excessive administration problems, it can be a cheaper way of establishing a plantation than "individual taungya". And this despite the fact that the Department has to pay for the farmer's labour - the main cost of the operation - whereas under the previous system the farmer himself bore most of the production costs like clearing, planting and weeding the saplings. Ball and Umeh (1981:8) calculated the economic rate of return in the establishment of teak and Gmelina arborea plantations in Nigeria under three different systems in 1975 and in 1980. "Departmental taungya" showed the highest returns for both species and at both dates, followed by "individual taungya", then by direct planting.

But the same authors state that the area under "departmental taungya" in Nigeria has declined considerably between 1975 and 1980 (see Appendix), and this partly because of administrative reasons, not only at the local level, but also higher up: for example the system was stopped completely in Ondo State, because revenue realized on food crops usually went to the agricultural division of the Ministry. In 1981, only Cross River and Ogun States were still carrying on "departmental taungya". Ball (1977:i) sums up the faults of the "departmental taungya" as "low agricultural crop yields and high supervisory commitments."

A further difference between departmental and individual "taungya" is that whereas the latter attracts mainly local farmers, the former may in addition attract people from other areas and even from towns, who are in search of a wage. Ball and Umeh (1981:2) state that "departmental taungya" introduced into Cross River State of Nigeria in 1971, is operated by "forest labourers who may have no previous experience in farming". In such cases it is easy to see why the agricultural crop yields may be low. However, this brings us beyond the scope of this study since for such labourers, "taungya" can in no way represent an alternative to shifting cultivation.

3.2.3 Permanent cultivation of annual crops: Lowland rice

Both the Sierra Leone and the Madagascar case studies give examples of projects which have attempted to encourage the production of lowland rainfed or irrigated rice as a substitute for upland rice cropping.

The major advantage of the former is its greater productivity per hectare and possibility of producing more than one crop per year. A number of advantages and disadvantages need to be considered to obtain a balanced view of what is an intensive and stabilized form of agriculture developed in Asia due to shortage of land available for more extensive forms of agriculture.

(a) High cost of irrigation in Africa up to the present time. However, only a small percentage of riceland is irrigated, much of it is swampland and valley bottom. Once initial preparation of the rice field is completed, labour costs of maintenance are relatively low compared to that required for clearing at successive intervals for the bush fallow-cycle.

(b) African farmers prefer working on upland rice on account of water-borne diseases (Bilharzia, Malaria, Guinea Worm). Development of new safe, effective low-cost drugs and the possibility of integrated pest control can substantially improve the health of farmers working under these conditions (T.N. Mather, 1983).

(c) Upland rice permits mixed cropping; a possibility not explored so far in valley-bottom rainfed or irrigated rice in Africa. The practice is common in Asia, however and could result in its introduction to lowland rice culture.

(d) Swamp and irrigated rice have the basic advantage of continued productivity during periods of cyclical drought when upland rice crops fail.

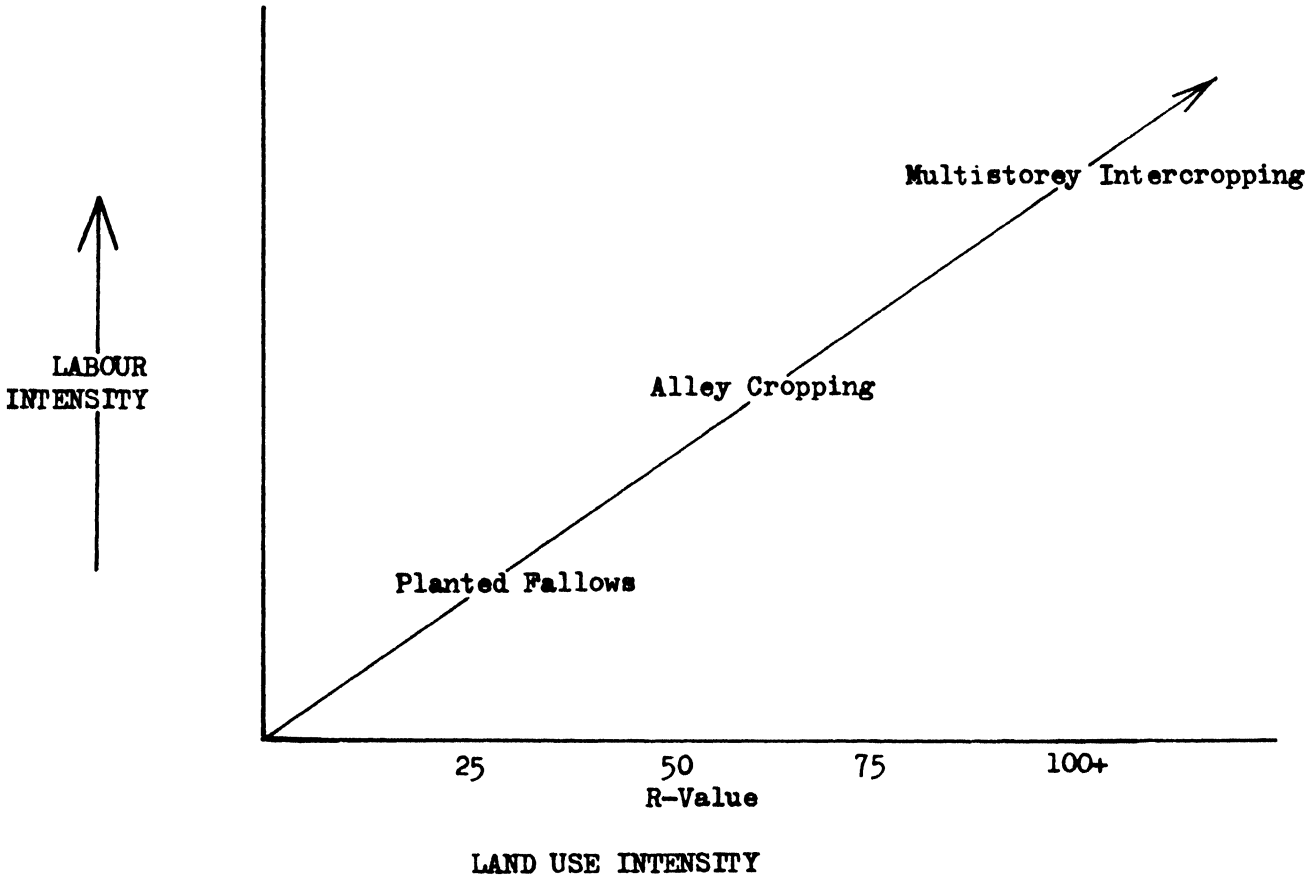
In summary, the Asian example of intensive development of swampland and rainfed valley bottom land could provide Africa with a means of attaining intensive cultivation of a staple crop under a stabilized system. However, the possibility of improving upland rice cultivation must not be ignored and the use of agroforestry techniques appears appropriate (planted fallows, alley cropping: see 3.2.4).

3.2.4 Agroforestry: alley cropping and multistorey intercropping.

Agroforestry is already practised by many African small farmers (see Olafson 1982:14ff). However, there is considerable agreement among scientists that agroforestry could, if practised more widely, provide a solution to some of the problems experienced with fallow agriculture in conditions of rising population densities and increasing land shortage (see Vergara 1981, Raintree 1980:108); indeed this is the assumption behind much of the work of the International Council for Research in Agroforestry (ICRAF), Nairobi, Kenya. Accordingly, certain field trials have been carried out in experimental research stations. For example, both the International Institute of Tropical Agriculture (IITA) at Ibadan, Nigeria and ICRAF have been carrying out field trials with alley cropping of the fast-growing woody leguminous genus Leucaena (see Hartmans 1981 and Okigbo 1981:44 for IITA and Raintree 1980:116 below for ICRAF). Unfortunately, there is as yet little information on the acceptability of these techniques to fallow farmers, since trials have been carried out in areas of permanent cultivation.

Work on the intensification of agriculture based on agroforestry techniques is particularly promising because it emphasizes the close relationship between the type of agricultural improvement on the one hand and the availability of labour and the

Figure 5: Hypothetical pathway for sustained-yield intensification in tropical farming systems



(Source: Raintree 1980:113).

intensity of land use on the other hand. Figure 5 presents a hypothetical progression from planted fallows to intensive multistorey intercropping, suitable for maintaining or improving per capita fields on a fixed land base under conditions of population pressure and land shortage.

a) In the early stage of intensification, as land pressure converts long-fallow farmers into short-fallow farmers, the use of appropriate tree legumes as planted fallows can increase and sustain the productivity of the land at fairly low labour costs.

b) By initially planting the fallow trees in appropriately spaced rows, the stage is set for the next phase of intensification in which progressively shorter rotations eventually result in permanent cultivation in the alleys between the pruned hedgerows of vigorously coppicing trees. The concept of alley cropping - the production of arable crops in the spaces between rows of of woody legumes which are pruned periodically throughout the cropping season to control shading and provide green manure mulch - is possibly the most versatile, effective, and widely adoptable of recent innovations in conservation farming.

   The practicality of the system has been demonstrated for a few arable crops and a number of woody legumes all of which, with the exception of Gliricidia sepium, have been listed on page 23. The characteristics of these species also resemble those on page 23 with additional stress on ability to coppice vigorously and yield high volumes of leaf matter under intensive pruning/ pollarding as well as a deep rooting habit for drought resistance and minimal surface root competition with the arable crops associated with them. The range of potential crop combinations and management options has, however, only begun to be explored. (Raintree 1980:116).

c) In the final, increasingly labour intensive, stages of intensification, the installed green manure 'fertilizer factories' can be maintained in place while additional upperstorey trees and intercropping practices are introduced to accommodate higher population densities, as the grandchildren and great-grandchildren of the original settlers arrive on the scene: multistorey intercropping. Multistorey intercropping is the system which offers the closest approximation to the characteristics of the tropical forests, and is not at all a new idea. It is in fact a prominent feature of compound gardens in densely settled areas of the tropics. The proposal here is to incorporate soil-improving economic tree legumes into the upperstorey of the system, and to choose species with light or seasonal canopies which permit the system to be extended to field crops.

Here again the characteristics of species ideal for multistorey intercropping incorporate high N-fixation capacity, low establishment and maintenance costs and special adaptive characteristics. However, a number of other essential characteristics are required such as a capacity for fast growth and planting at dense spacing, light canopy permitting the growth of understorey crops; deep rooting habit and minimal surface root competition; nutrient-rich and readily-humified foliage; high yields of economic byproducts such as high-protein pods; capability for easy and cost efficient harvesting of the above products. The species suitable for multistorey intercropping are Acacia albida Prosopis spp., Sesbania grandiflora, Leucaena leucocephala, Samanea saman and Tamarindus indica (Raintree 1980:116-117).

If the motivation exists, there is no reason why the scheme of intensification here envisaged cannot be run "ahead of itself" to generate higher incomes for industrious rural families well in advance of population-pressured necessity. The scheme likewise admits of great flexibility in the combination of elements from different "stages" for simultaneous production of optimal products for particular localities (see Raintree 1980 and 1983).

CONCLUSIONS AND GUIDELINES

1. The terms 'shifting cultivation' and especially 'shifting cultivator' have been found to be used in a number of inaccurate ways; this has had the effect of confusing the variety of agricultural systems found in forest areas and the variety of reasons for which forest trees may be cut by different people. It is not only misleading to group all these people together; as long as we hold inaccurate ideas about 'shifting cultivators' we are unlikely to devise satisfactory alternative agricultural strategies for them. Following FAO convention and such respected agriculturalists as Ruthenberg, it has been found useful to equate shifting cultivation with long fallow agriculture, and to distinguish it from short fallow agriculture.

2. Shifting cultivation as defined above is no longer as common in Africa as formerly. It continues to exist in areas of low population density. Short fallow agriculture, on the other hand, is common.

3. Moreover, shifting cultivation is nowadays usually combined by producers with other methods of cultivation, for example short fallow and/or continuous cultivation nearer the homes. Two points follow: first, the houses of farmers who practise shifting cultivation are usually permanent buildings and do not 'shift' any more. And second, shifting cultivation is nowadays more usually a component in a complex farming system than a complete farming system in itself.

4. Farmers are constantly and spontaneously adapting their agricultural practices to changing conditions of population density and land availability; adapting their crop rotation practices and/or switching part of their land to a more intensive (or, in appropriate cases, a more extensive) method of land cultivation.

5. In some areas there may be considerable constraints against the intensification of agriculture from shifting cultivation and short fallow cultivation to continuous cultivation. One is the low returns to labour of continuous (unmechanized) cultivation when compared with short fallow and even more so with shifting cultivation. Other constraints are the difficult access to, and high prices of, fertilizer and other agricultural inputs, and the lack of security of land tenure, which discourages investments in such inputs.

6. In such areas, a crisis point may be reached, characterized by population pressure, land shortage, soil degradation and decreasing yields. Such crisis areas may be associated with the abandoning of shifting cultivation in favour of short fallow and/or continuous cultivation, but rarely with the continuing presence of shifting cultivation.

7. Interventions are of two types: firstly, improvement of fallow agriculture, for example planted fallows, is appropriate where trends of population density and distribution of access to land are such that farmers have enough land to retain a sufficient fallow period on some or all of their lands in order to restore soil fertility; and where this situation seems unlikely to change in the near future.

8. Where it is becoming difficult for small farmers to get access to sufficient amounts of land in order to practise fallow agriculture, then it is appropriate to turn to alternative methods of cultivation, in particular continuous agriculture. Under such conditions, if the farmers have not already switched to such alternative methods, it is likely that there are serious constraints. Every effort should be made to communicate with the farmers in order to determine what these constraints are.

9. Of utmost importance are the physical constraints, about which the farmer is likely to have a considerable amount of practical knowledge. For example fallow agriculture is often deliberately practised in poorer soils, which need quite considerable inputs of fertilizer in order to support continuous cultivation.

10. Socio-economic constraints are also of major importance. Alternatives should not assume that farmers have security of land tenure. Rather, this should be ascertained. In some cases, it may be necessary to implement a degree of local land reform before the 'alternative' may be an attractive proposition for fallow farmers. This is particularly the case where planting of trees is concerned. It should also be ascertained whether the farmers have access to enough labour in order to adjust to the higher labour requirements of continuous cultivation; and whether they have enough money to buy the fertilizer and other inputs which may become necessary.

11. In order not to burden the farmer with the cost of chemical fertilizer, the use of natural fertilizer should be substituted wherever possible. Apart from the use of 'green' manure, more attention should be devoted to recycling animal manure as fertilizer and generally coordinating animal production and crop farming activities.

12. Off-farm activities should always be borne in mind as alternatives to fallow farming in crisis areas: particular attention should be devoted to the possibility of diversification to include such activities as the small-scale exploitation of wood and other forest products.

13. The use of perennial as opposed to annual agricultural crops should be encouraged where appropriate, in order to exploit the soil in the most stable way. In general the planting of trees is seen to be one of the most effective ways of preventing soil degradation.

14. The alternative should also take into account the sexual division of labour: in many parts of Africa where fallow agriculture is practised, women carry out more of the farming work than men with the exception of clearing. In some places they also do clearing work (see Carter and Mends-Cole 1982:62 in respect of Liberia); and in other places they not only carry out farming work but also farm in their own right, taking management decisions in their own land and even employing male hired labour (see Spiro 1980:19 in respect of Oyo State, Nigeria). Interventions in such cases should address women farmers as well as men.

15. This report has dealt at great length with "taungya" systems. This is largely because, being older systems, there is more information about farmers' reactions to them. The main conclusion to draw from experience with "taungya" is that since it is primarily a system of plantation establishment and since farmers derive no profit from the trees they plant which remain the property of the Forestry Department, the farmers are not highly motivated to make it work: they are mainly interested in getting access to land for their crops. Great scope is seen in proposals for agroforestry or community forestry in which the farmers have responsibility for the trees they plant, and derive profit from them.

16. Of the many proposed agricultural improvements and alternatives to fallow farming (better seed, fertilizers, minimum tillage, green mulch, mixed cropping, etc.) only very few have been tried out in collaboration with fallow farmers. The great majority have so far been field station trials only. Furthermore, some of the practices are already carried out by some fallow cultivators, especially mixed cropping and minimum tillage. Again what is needed is more of a dialogue with farmers, so that both foresters and agriculturalists may learn from farmers considerable local experience, and so that alternatives proposed in particular areas may be well adapted to the particular needs of the local farmers.

17. More attention should be paid to the particular reasons why farmers use fire, in the local context. Less emphasis should be placed on fire prevention programmes; instead, farmers could be advised on ways of improving fire management, bearing in mind the measures they already take.

APPENDIX

B E N I N

A. General information

Location: three southern provinces
Rainfall: 1,000–15,000 mm annual average
Population density: 150 persons/km^2.

B. Cultivation practices

1. Main food crops: maize, cassava, yams, beans, grown in the following way: average of three successive years of cropping (6 seasons) followed by three years of fallow (in the 1960s the fallow period was 6–8 years according to FAO/African Development Bank 1982:37). According to Tran Van Nao (pers. comm. 1983), the cultivation period may in some areas be up to four or five years, followed by a fallow period of only two to three years.

2. Main cash crops: oil palm, grown on permanent plots.

3. Others: fruit and vegetables grown on permanent plots near villages.

C. Improvements and alternatives

Government programme of rural development and extension (with the Centre d'Action Régional de Développement Rural - CARDER - directorate) includes three types of action in forest areas:

1. Teak plantations and nurseries for small farmers
2. Eucalyptus plantations for fuelwood
3. Agroforestry for small farmers, in particular, planting fallow land with *Acacia auriculiformis*, in order to enrich the soil with humus and nitrogen as well as producing fuelwood quickly (Worou and Tran Van Nao 1982:10). By 1982, some 200,000 saplings had been produced for distribution by local cooperative organizations. Not all distributed and planted, due to farmer preference for eucalyptus (Tran Van Nao per. comm. 1983).

G H A N A

A. General information

Source: Ghana case study except where otherwise stated.
Location: Site of FAO project GHA/74/103 "Development of Forestry Energy Resources": some 1,432 km^2 in Tarkwa Forest District, southwestern Ghana. 41.2% of this region constitutes the Subri Forest Reserve.
Rainfall: annual average 1500 mm in the east and 1875 mm in the west of the region.
Population density: 40.6 persons to the km^2 in Tarkwa Administrative District; lower in Subri area because of a concentration of population in mining towns outside the area in question.

B. Cultivation practices

1. Permanent cultivation of tree crops: cocoa (14.65% of land available for agriculture is under cocoa), rubber, oil palm, citrus, coconut palm. Ten to 15% of farmers had permanent crops along with food crops.

2. Shifting cultivation of food crops (a greater proportion of arable land is devoted to SC): maize, cassava, plantain, cocoyam, yams. Mixed cropping, on small mounds (except maize). Cultivation period: 2 years (occasionally three, rarely four); fallow period three years (though would have preferred five or more); (rarely, two and one year, see p.

C. Alternatives

1. Individual taungya: A system of individual taungya was introduced in 1928 in Ghana: "The early plots given out were small, of the order of 2-4 hectares per annum and usually scattered, not too easily accessible and did not constitute manageable plantation units. Tending for the tree crop, particularly after the farmer had left the site, was therefore inadequate and it cannot be said that success was commensurate with effort. The area treated by this system, as at December 1966, was 4,774 ha and some 15,060 ha were added between 1966 and 1973. The afforestation effort was intensified in 1968 with an annual target of 13 km^2 in 5 forest reserves and stepped up in 1972 to an annual target of 104 km^2 scattered over some 36 forest reserves. This meant more land to the taungya farmer." (Brookman-Amissah 1978:4).

   In the Subri area, farmers prepare the site (without burning), provide pegs, assist with pegging and tending.

2. Departmental taungya: A different system of taungya was introduced in 1969, in an attempt to solve some of the problems caused by an over-abundance of land available to the taungya farmer: accordingly, the Forestry Department was to fulfill all the functions previously performed by the farmer, including the marketing of food crops; the proceeds would thus offset the cost of establishing the tree crop (Brookman-Amissah 1978:4). The wage labourer would have the right to buy a ration of food items from the Department.

3. Proposed improvement: The "Subri Conversion Technique" is a technique for clearing forest without burning and with the maximum use of cut vegetation. Most of it is extracted as wood, charcoal or material for small-scale local industries such as carving and basket weaving; and the remainder, in the form of small branches and leaves, is to be used as green mulch for the agricultural crop. This improvement is being introduced in the context of an FAO-supported project, "Development of Forestry Energy Resources in Ghana", whose long-term objectives are to establish a sustained supply of wood firstly for charcoal production for both domestic and industrial use and secondly as raw material for a pulp and paper mill (envisaged but no progress yet made in establishing the industry).

IVORY COAST

A. General information

Source: The Ivory Coast case study.
Location: southwest Ivory Coast; bordered in the west by the Liberian frontier and in the east by the Sassandra River.
Rainfall: annual average 1600 (NE) to 2400 (SW) mm
Population density: 3+/km^2 in 1976 (1.4/km^2 in 1972).

B. Cultivation practices

1. Forest people (oubi, Bakwé)

   a) Food crops especially hill rice (also manioc, bananas). Cultivation period 1-2 years; fallow period 3-4 years.

   b) Tree crops (coffee, cocoa) plus food crops in years 1,2. Use axe, do not make mounds.

2. Baoulé immigrants: permanent farming only (p. 21); no use of fallows. Perennial crops (coffee, cocoa), plus annual food crops in years 1,2: yams. Also rice, manioc, vegetables and bananas. Make mounds, use hoe.

C. Alternative

Cultivation of perennial agricultural crops. Not necessarily a more stable form of landuse. Shifting cultivation has, in this area, been a staple form of landuse for several decades during which very low population densities were maintained and large tracts of forest were left undisturbed. The pressure on forest resources started with the advent of the government-sponsored opening up of the area for commercial exploitation, which resulted in the rapid development of a pioneer front subject to intense changes in landuse. Although this resulted in temporary cultivation to be "stabilized" into permanent cultivation, it did not result in a spatial stabilization of landuse, nor in a stabilization of the interacting components of the farming system (see pp. 149-153 of Ivory Coast case study).

L I B E R I A

A. General information

Location: forest areas nationwide.

B. Cultivation practices

1. (From Ruthenberg 1980:55-6 quoting van Santen 1974, relating to Bong Country, central Liberia):
"Farm holdings include:

   - upland rice (average 1.6 ha: 1-3 crop years followed by 4-20 fallow years);
   - lowland cultivation: rice followed by sugar cane (for rum, the major cash activity); less frequent fallow, mainly for weed control;
   - permanent home plot (about 0.4 ha) with plantains, bananas, 4-5 different fruit trees, some root crops, and vegetables."

2. (From Appleton 1982:2):

   - upland rice intercropped with cassava, maize, pumpkin, vegetables; fallow period 3-6 in populated coastal areas, central and upland savannah zone of the northwest; and 8-12 years in the sparsely populated high forest zones of the northwest and southeast regions.

C. Alternative

"Agrisilviculture" (or in the vocabulary used in this report: "taungya") incorporated into reforestation programme initiated by the Forestry Development Authority (FDA) in 1974.

"The FDA Scheme slightly differs from countries where agrosilviculture is well developed. Land preparation up to, and including, the phase of burning is carried out by the Forestry Development Authority. Farmers then come in and plant their rice crop at a nominal fee of $20/acre*. This fee is charged to control the acreage given to each household and to help retain part of the cost for land preparation. The rice and forest tree crops are planted simultaneously. This is done so that the tree will receive an initial boost in growth from burnt vegetation and early tending given by the farmers.

Only rice, maize and pumpkin are allowed to be intercropped with the forest trees. After harvesting the rice the agricultural aspect of the programme discontinues. The agricultural component is incidental as emphasis is placed on the forest tree crops. The present agro-silviculture scheme is very localized and is practised on a very moderate scale as compared to the extent of the forest destruction and number of households engaged in the swidden/slash and burn method of cultivation. At present only 1,400 acres, capable of accommodating 400 shifting households, are on the average reforested annually under this arrangement." (Appleton 1982:8-9).

* One Liberian dollar = 1 US dollar.

MADAGASCAR

A. General information

Source: The Madagascar case study.
Location: Vavatenina, province of Toamasina.
Rainfall: 2,000 mm+
Population density: 83/km^2.

B. Cultivation practices

1. Hill rice: one to two year cultivation period followed by fallow which is being reduced from 6 to 3 years. All farmers practise this.

2. Swamp rice: majority of farmers have at least small amounts of this.

3. Cash crops: coffee, cloves, bananas, sugar cane, pineapple. All farmers grow some.

   Most farmers rely on their own rice for about 3 months in the year; for the rest they rely on proceeds from cash crops and from paid labour with the few wealthy farmers.

C. Improvement

Proposal to enrich fallows with Grevillea which would be used as fuelwood when the fallow was cleared for agriculture. To be implemented if and when Phase II of the project is approved. To date, nothing has been attempted with regard to enriching the fallow vegetation which, if the title of the project is anything to go by, might have been one of the project's main aims. Instead, farmers are encouraged to turn to alternative uses of this land apart from the fallow cultivation of hill rice.

D. Alternatives

Farmers are encouraged to plant perennial agricultural crops on land previously devoted to hill rice. Also to cultivate more swamp rice in order to depend less on hill rice; in this context, irrigation schemes are being devised for the slopes, and some terracing is under way. Finally, some slopes are being planted with eucalyptus trees for fuelwood.

N I G E R I A

A. General information

Source: Ball and Umeh 1981.
Location: Nine states in southern Nigeria: Anambra, Bendel, Benue, Cross River, Imo, Kwara, Ogun, Ondo, Oyo.

B. Cultivation practices

No details on cultivation practices of those who practise taungya, who are either licensees under individual taungya, or paid workers under departmental taungya. But these are areas of fallow agriculture.

C. Alternatives

1. Individual taungya (or traditional taungya): "In 1975 there were 24,427 traditional taungya farmers in the southern states of Nigeria. It was estimated that a further 19,500 people had casual employment for 6-10 weeks of the year in traditional taungya farms, but no reliable figures could be obtained of the number of family members of the taungya farmer who worked on the farm. In 1979, however, the number of taungya farmers had fallen to 17,744, despite the area of traditional taungya having remained nearly the same and the availability in some states of taungya farms which were not planted with trees.

   This may reflect the continuing lack of recruits to traditional taungya farming (see Olawoye 1975 and Ball 1977). Another factor affecting employment in taungya farming has been the recent introduction of universal primary education; there may be fewer young family members available, resulting in an increase in casual employment during land preparation, mounding and harvesting.

   Yams, maize and vegetables, which make the greatest demands on soil fertility, are grown first, followed by cassava. A second crop of maize may be grown, but it is low yielding and is generally used for seed the following year. In the past it was forbidden to grow certain crops, such as cocoa, rubber, plantains, etc., because they were permanent or semi-permanent crops which competed with the forest crop and could lead to alienation of the forest reserve if they grew for long enough to establish some sort of rights. Crops such as rice or guinea corn were banned because they are aggressive root competitors and tobacco was banned probably because of root eel worm. Cassava could only be grown if it was the erect and not the spreading variety, but when taungya started in Bendel State forty years ago it was banned completely. These rules have now been considerably relaxed. Plantains may be grown in Ogun, Ondo and Oyo States as boundary markers and in Bendel State throughout the plot. Rice and guinea corn are raised in Bendel, Kwara and the Eastern States.

The tree crops planted in Nigeria are presented in the following table:

Tree species planted in taungya farms in some States of Southern Nigeria in 1975

State	Tree Species, in order of importance
Anambra	Gmelina arborea, Teak
Bendel	Gmelina arborea, Teak, Opepe, White Afara
Cross River	Gmelina arborea
Imo	Gmelina arborea, Teak, White Afara, Opepe
Kwara	Gmelina arborea, White Afara, Teak
Ogun	Gmelina arborea, Teak, Opepe
Ondo	Teak, Gmelina arborea, White Afara, Opepe
Oyo	Gmelina arborea

Generally the licensees are responsible for tending the tree crop after planting until they harvest the final food crop, which is usually cassava. In Bendel State, however, the Forest Department do the lining out and pegging but the licensees plant the trees. This can lead to abuse. Poor planting and lack of weeding have been noted at several other centres in other States, and in some places deliberate damage to trees."

2. Departmental taungya: "In 1975/76 there were 1221 jobs created in departmental taungya, either in growing or in processing the food crops. No reliable estimate is now available but the figure has been considerably reduced because the area has fallen considerably (from 1448 ha to 405 ha) and because none of the cassava crop is processed into gari. In departmental taungya the only two crops grown are maize and cassava. In Cross River State, two crops of maize may be grown, the second being for seed but usually it is only one. A new development is that the Ondo Afforestation Project will introduce Cowpea this year."

S E N E G A L

A. General information

Source: The Senegal case study and Oxby 1983
Location: Casamance
Rainfall: 1,000 mm.

B. Cultivation practices

1. Permanent cultivation of vegetables, fruit trees, some cereals and legumes around villages; usually fertilized with manure.

2. Short fallow cultivation of millet, sorghum, groundnuts near the village.

3. Wet rice in the swamps.

4. Long fallow cultivation of cereals and groundnuts in plots cleared in the forest away from the village.

C. Alternative

CGOT* carried out mechanical clearing of forest (6,500 ha all together were cleared during the 1940s, 1950s and 1960s) in order to introduce continuous cultivation, mainly of groundnuts and rice. Local farmers were not involved much since the project recruited paid workers, many of whom came from other regions or countries. Deforestation was increased as a result of the project, and there were severe problems of soil degradation, far worse than those associated with the local forms of agriculture.

* Compagnie Générale des Oléagineux Tropicaux

SIERRA LEONE 1

A. General information

Source: The Sierra Leone case study
Location: Eastern Province
Rainfall: between 2,500-3,000 mm annual average
Population density: 50 persons per km^2 in Eastern Province in 1974.

B. Cultivation practices

Upland mixed food crops combined with swamp rice and tree cash crops (cocoa, coffee, oil palm). In the case of food crops, average fallow of 7.4 years in eastern province follows 2 (or sometimes 1) years cultivation.

C. Alternative

Eastern Province Integrated Agricultural Development Project.

Implications with respect to fallow: increased concentration on swamp rice and some perennial cash crop cultivation (cocoa and oil palm, not coffee), with inputs and extension; upland fallow cultivation discouraged, especially on steep slopes.

Achievements: more success with perennial crops than with swamp rice.

Reasons: farmers' preference for upland rather than swamp cultivation, on account of its lower labour requirements.

SIERRA LEONE 2

A. General information

Source: Koroma 1982
Location: nationwide.

B. Cultivation practices

Bush fallow and swamp rice.

C. Alternatives

1. The National Programme of Taungya

The taungya procedure practised in Sierra Leone is as follows:

"Each year planting areas are demarcated in December or January and invitations issued through the Paramount Chiefs to the farmers who formerly owned the land. It is the original land-owners who have the first rights to farm the land in exchange for clearing the bush fallow and following the planting guidelines set out by the government. Only the original landowner can reject the offer to farm and pass on the rights to someone else.

After the bush is felled, the cut vegetation is allowed to dry and is then burned about March-April. The Forestry Department lists crops that are allowed to be cultivated and lays down other requirements. In June-July, the young forest trees are planted by the forestry staff, and this is done after the farmer has planted his own crops. Spacing for the forest trees varies according to site and species to be employed. The general trend is toward wide spacing, e.g. 2.5 x 2.5 m, 3 x 3 m, and 4.5 x 4.5 m for Gmelina arborea, Terminalia ivorensis, T. superba, Cordia alliodora, and Nauclea diderrichii. The principal agricultural crop used in taungya is rice, but farmers are allowed to sow maize, guinea corn, peas, sorghum, cassava, and okra. During this time, the farmers tend the young trees in addition to their agricultural crops.

After the second, and sometimes the third, year the farmer is allotted another plot. In most cases where there is no land hunger and in remote areas where the Forestry Department is obliged to carry out rapid afforestation, the farmers are the forestry employees. Forest villages are built for them, and all the agricultural crops they cultivate belong to them." (Koroma 1982:68-9).

2. Proposed taungya with perennial agricultural crops

In order to increase agricultural production and provide a longer-term arrangement for farmers, the Forestry Department began in 1976 to introduce cocoa, coffee and cola as understoreys in Terminalia ivorensis and Terminalia superba plantations.

"Initial experiments at Kasewe Forest Reserve in the late 1950s had proved satisfactory, and the indications are that coffee will soon become the main understorey in extensive areas of wide espacement plantations in forest reserves and the line-planted areas in native administration forests. These perennial crops are being introduced as understoreys at spacings of 7.5 x 7.5 m, 9 x 9 m, and 10.8 x 10.8 m such that the final crop will be 178, 121, and 85 stems/ha respectively when the plantations are between 12 and 15 years old. It is hoped that when the agricultural crops have outlived their usefulness (about age 30), the whole area will be clear felled and replanted by the taungya system. Maintenance from the time the agricultural crops are planted will be carried out by the farmer (the original landowner or holder), to whom the plantation would be leased on payment of an annual rent to be mutually agreed upon."

SIERRA LEONE 3

A. General information

Source: FAO/World Bank 1982, Appendix 2
Location: Adjacent areas of central Sierra Leone in the northern and southern provinces.
Rainfall: 2,500-3,000 mm
Population: 40 to 100 persons/km^2.

B. Cultivation practice

Upland mixed food crops combined with tobacco growing; the latter has been of increasing importance in the last 10 years. Bush fallow 5-8 years; forest rarely more than 10 years old. In the north of the region in question, where rainfall is lower, fallow is savanna, including *Lophire alata* dominated savanna.

C. Alternative

Fuelwood plantations (eucalyptus) and community forestry plantations: for fuel, poles, shade for agricultural crops and dwellings, soil improvement, ease of successful culture and minimal effect on growth of agricultural crops.

Proposed species: *Acrocarpus fraxinifolius*, *Acacia auriculaeformis*, *Albizzia falcataria*, *Leucaena leucocephala*.

TANZANIA 1

A. General information

Source: Vieweg and Wilms 1978:228-9
Location: the Kilombero Valley, southern Tanzania (higher land, not low-lying central)
Rainfall: 1,200-1,400 mm
Population density: 20-23 persons/km^2 rising. Some farmers in the lower population areas shift their dwellings; most do not.

B. Cultivation practices

3-5 years cultivation followed by 10-20 years fallow. Fallow period depends on the type of soil; the farmer often judges the fallow sufficient to restore soil fertility when the original Hyparrhenia grass has again become the dominant species of the vegetation. Cultivation of upland rice, also maize and cassava. All crops planted on ridges. Weeds removed and laid in the furrows where they serve as green manure after splitting the ridges for the next crop. Only tool: hand hoe.

C. Alternative

Permanent cultivation of annual crops on 30 ha at Katrin Research Station.

1. Results to date

"The crop rotation differed somewhat from field to field, but generally the sequence was: maize, rice, soyabean, rice or sesame, rice, rice. Dressings of artificial fertilizers were given to all crops; rates of application to rice were usually 20 kg of N (as ammonium sulphate), 26 kg of P (as triple super-phosphate) and 40 kg of K (as potassium chloride) per hectare. Despite the dressings of fertilizer, yields decreased gradually, but it was not possible to determine to what extent it could be attributable to the effect of season or to an ever increasing amount of weed growth which could not always be handled properly.

During the sixth year of cropping, large patches of plants in the fields grew extremely poorly and no seed was harvested. On one field, soyabeans suffered considerably, remaining small before finally dying. In another field devoted to a rice variety trial, all 16 varieties germinated well, but few tillers and even fewer ears were produced before the plants died without a single grain being harvested. Soil analyses showed that during the six-year cropping period the pH of the soil (as measured in $CaCl_2$ solution) was reduced from 5.4 to 4.1. This reduction was a very large one, taking into account the relatively low rates of application of N and P. Lime applied to the final soyabean crop raised the pH from 4.1 to 4.9, but rice sown as a test crop on the site of the same experiment in 1973 was destroyed by wild animals and no crop was harvested. The remaining land was put down to fallow."

2. Research work in progress

"Leaf and soil analyses of a detailed nature are being undertaken, but no results are available yet. Several trials have been laid down in an attempt to find a sound cropping system for this type of soil. One long-term experiment is being used to compare 12 different crop rotations in which rice is the main crop and leys are also included. Other experiments are being used to compare high and low rates of fertilizer and the effect of lime. In one trial Mo significantly increased the yield of rice straw and narrowly failed to do so for grain yield."

3. Conclusion

"The results obtained so far from trials on the long-term cultivation of annual crops with mechanization on a pale sandy groundwater laterite soil have not been encouraging. After six years cropping, yields fell to zero, despite reasonable dressing of NPK. The application of cattle manure and lime markedly improved the crop but neither seems to be a practicable proposition because little cattle manure is produced and the cost of lime is uneconomically high. Liming might also aggravate the problem by increasing mineralization of organic matter.

At the present early stage of investigation, no improvement can be suggested on the customary method of shifting cultivation as practised by farmers on soil of this type."

TANZANIA 2

A. General information

Source: case study of Hado, Tanzania
Location: Hado area, Kondoa
Rainfall: 500–800 mm annual average
Population density: 21 or 24.5 persons/km^2 (1978) (different figures on pp 26 and 27).

B. Cultivation practices

Of 120 farmers interviewed, 83 did not practise fallows, 37 did. For those who did, an average of 2 years fallow followed an average of 5 years cultivation (p 44 of case study). In other words, this is not shifting cultivation; it is usually permanent cultivation.

C. Alternative

Tree planting for the Forestry Department, for fuelwood, community woodlots and for reducing soil erosion. Four tree nurseries have been established and by December 1982 some 7.1 million seedlings were being raised. There were 1690 ha of 'demonstration plots', ridging had covered some 95 km^2. There was a good participation rate of farmers in tree planting, but tending was not rigorously pursued. Interest in tending trees would be greater if the trees planted were multipurpose, i.e. if they could be integrated with the farmers' agricultural practices, as agrisilviculture. (p 55 of Hado case study).

TANZANIA 3

A. General information

Source: case study of Usambara, Tanzania
Location: Usambara mountains
Rainfall: 1,000-2,000 mm depending on altitude
Population density: 137 persons/km^2 or 185 persons/km^2 for the area of cultivable land (1978).

B. Cultivation practices

No recent data: probably shifting cultivation in pre-colonial times, then a change from forest fallow to short grass fallows during the early colonial period, associated with the spread of cash cropping and government reservation of land. Now permanent cultivation is the most common form of agriculture.

C. Alternative

Vegetable growing in the context of the Lushoto Integrated Development Project. An evaluation in 1974 showed that:

a) the high-input agricultural practices used, based on methods from industrial countries, were not appropriate in this area;

b) the positive aspects of traditional cultivation techniques had been neglected and

c) it was envisaged that subsistence farmers would buy vegetables and thereby improve their diet; in fact the farmers could not afford to do this. (pp 20-21 of Usambara case study).

T O G O

A. General information

Source: Nadjombe 1982:70-72
Location: nationwide.

B. Cultivation practices

Shifting cultivation (no details).

C. Alternative

Taungya, involving a succession of different arrangements from the 1950s to the present time.

1. Individual taungya

a) 1954: Food crops with teak in disbursed plots.

"At first, the farmers were allowed to select their own site and desired acreage in a forest reserve, according to their own criteria and abilities. Using traditional methods, they prepared the ground and planted and nurtured the seedlings supplied by the Forestry Department, which, in principle, supervised all operations. The food crop harvests belonged entirely to the farmers, who were authorized to open up new plots according to their needs. When the cover of the teak plants began to hamper the development of food crops, the Forestry Department resumed responsibility for the care of trees. The farmers were also allowed to choose the food crops they wanted to grow, according to practical experience. Only perennial crops, such as oil palms, citrus fruits, coffee, and cocoa were forbidden."

b) 1958: Food crops with teak in adjacent plots.

"As early as 1958, farmers were compelled to cultivate plots in a continuous block rather than interspersing them throughout the forest. This regulation derived from the difficulties associated with managing small heterogeneous plots that were spread throughout the forest and that included seedlings of many different ages. With regard to the kind of crops to be grown, it was recommended that only corn, yams, and beans be cultivated together with teak. This recommendation was based not on scientific evidence but rather on observations of poor teak growth in combination with other crops such as cassava, cotton, and sorghum."

c) 1972: Food crops with *Terminalia superba* with incentives in the form of bonuses in cash and kind.

"With FAO assistance, the Office de Développement et d'Exploitation des Forêts (Forest Development and Exploitation Authority, ODEF, a government organization set up in 1971 to stimulate reforestation activities) reintroduced the taungya on its sites in 1972, adding new

elements such as incentives in the form of bonuses in cash and in kind. The cash bonus was fixed at 6,000 Fr. CFA (in 1981, 400 Fr. CFA = US$ 1) and there were supplies worth 23,000 Fr. CFA for the first year of the contract. These incentives made it possible to plant more than 1,200 ha of Terminalia superba before the system encountered two difficulties that led once more to its abandonment.

The Terminalia superba plantations were established in dense, semi-deciduous woodlands that are much sought after by farmers, who clear them for food crop production. The new taungya system allowed the planting of corn, which in Togo is generally grown on forest clearings and is not the leading rotation crop. Because the ODEF was unwilling to allow rotation of crops under the taungya system, farmers felt it was pointless to continue with the system, as grasslands were readily available all around the forest reserves; and T. superba and teak plantations were usually handed over to the Forestry Department after two years of cultivation by farmers. Since these plantations were far from human settlements, there was inadequate labour for maintenance and reforestation activities. A great many of the plantations were thus left in a deplorable state."

2. Departmental taungya: paid labour to establish food crops with eucalyptus.

"Given that the taungya system faced virtually insurmountable difficulties at the sociological and technical levels, a new formula had to be found. Thus, under state supervision, a semi-mechanized eucalyptus reforestation site was established near a major urban centre capable of supplying needed labour. Both food and tree crops were to be cultivated as before but the State would reap the benefits of all harvests and would pay labourers a wage."

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